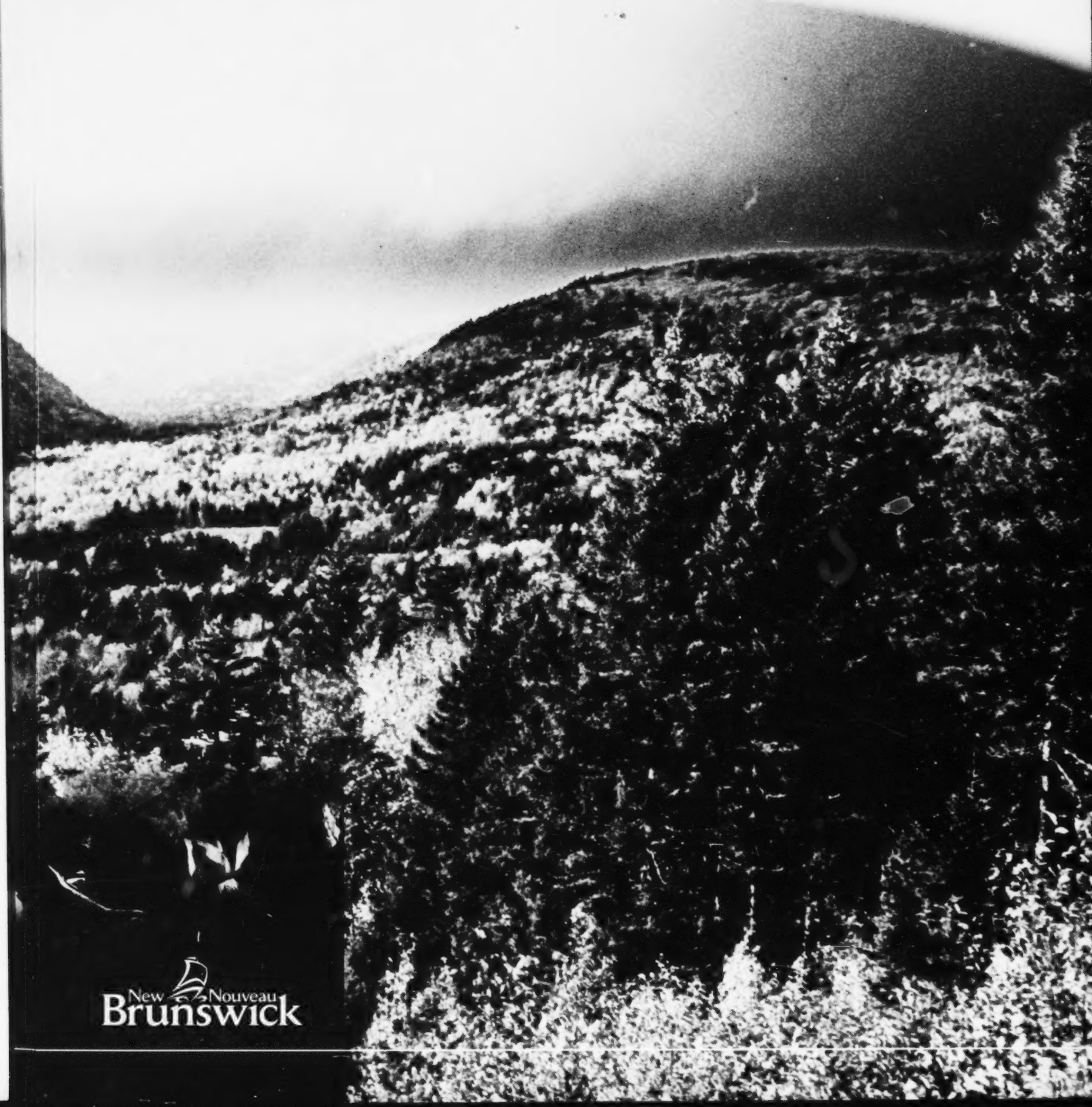
Our Landscape Heritage

The Story of Ecological Land Classification in New Brunswick



New Nouveau Brunswick

Our Landscape Heritage:

The Story of Ecological Land Classification in New Brunswick

Second Edition 2007
New Brunswick Department of
Natural Resources

New Nouveau
Brunswick

Library and Archives Canada Cataloguing in Publication

Our landscape heritage [electronic resource] : the story of ecological land classification in New Brunswick / general editor: Vincent F. Zelazny. – 2nd ed.
Prepared by the Ecosystem Classsification Working Group.
Issued also in French under title: Notre patrimoine du paysage, l'histoire de la classification écologique des terres au Nouveau-Brunswick.
Originally issued 2003.
ISBN 978-1-55396-203-8

1. Land use–New Brunswick–Classification. 2. Ecology–New Brunswick–Classification. 3. Ecological regions–New Brunswick. 4. Ecological districts–New Brunswick. 5. Biotic communities–New Brunswick. 6. Vegetation classification–New Brunswick. 7. Ecological surveys–New Brunswick.

I. Zelazny, Vincent Frank, 1957-
II. New Brunswick. Dept. of Natural Resources
III. New Brunswick. Ecosystem Classsification Working Group

HD319.N4097 2007 333.7309715'1 C2007-901667-7

The Ecosystem Classification Working Group:
Vincent F. Zelazny, General Editor
Gwen L. Martin
Maureen Toner
Martha Gorman
Stephen Clayden
Mark Colpitts
Hilary Veen
Betty Godin
Bryce McInnis
Chris Steeves
Lawrence Wuest
Mark R. Roberts

Copyright ©2007 Department of Natural Resources, Province of New Brunswick, Fredericton, New Brunswick, Canada

Acknowledgements

We want to thank the following persons who generously provided assistance in one way or another. However, any errors, omissions, or mistakes of interpretation, are solely the responsibility of the General Editor.

Thanks to: Pat Allen, Serge Allard, Paul Arp, Thierry Arseneau, Mélanie Aubé, Bruce Bagnell, Dave Bewick, Gart Bishop, Maryse Bourgeois, Colin Bowling, Sheila Carlisle, Don Carroll, Mark Castonguay, Stephen R. Clayden, Nathalie Comeau, Mike Coté, Roger Cox, Peter Cronin, Steve Currie, Greg Davidson, Janette Desharnais, Anthony Diamond, Mike Dillon, Bob Dick, Tim Dilworth, Brent Evered, Sherif Fahmy, Les Fyffe, Jim Goltz, Lester Hartling, Mike Hayter, Peter Hilder, Harold Hinds, Nadine Ives, Randy Leblanc, Terry Leonard, Judy Loo, O.L. Loucks, Ron Loughrey, Andrew MacDougall, Taumey Mahendrappa, Scott Makepeace, Ian Marshall, Martin Marshall, Bruce Matson, Don McAlpine, Judith Mercer, Randy Miller, Nadine Morris, Tom Ng, Reg Parsons, Christine Paré, Donna Mae Perley, Olivier Pfister, Randy Power, Janet Proude, Toon Pronk, Lorrie Roberts, Roger Roy, A.A. Ruitenberg, Dwayne Sabine, Allen Seaman, Inuk Simard, Jamie Simpson, Gérard Sirois, Charles Solomon, Sarah Taylor, Jacques Thibault, Tony Thomas, Jane Tims, Stewart Tower, Don Vail, Herman vanGroenewoud, Tim Vickers, Ken Webb, Tim Webb.

Dedicated to the memory of Bryce McInnis, our friend, colleague, and collaborator in this work.

Photographic Credits

Unless otherwise indicated, photographs, charts, and maps in this publication are courtesy of the Province of New Brunwsick. All other photograph or map credits appear following the image caption.

General Disclaimer

While every effort has been made to present accurate maps and data, the Department of Natural Resources does not guarantee that the maps and data are correct.

Users of facts presented in this report, as well as the data herein must take care to ensure that applications envisaged for these data are appropriate uses, and that take account of the accuracy of mapped data as well as issues of scale.

The opinions expressed in this document are solely those of the authors and do not necessarily represent the opinion of the Minister of Natural Resources or of the Department of Natural Resources.

NATURAL RESOURCES
New Nouveau Brunswick CANADA
RESSOURCES NATURELLES

"Your Environmental Trust Fund At Work"

THE NEW BRUNSWICK MUSEUM

FUNDY
MODEL FOREST NETWORK
RÉSEAU DE FORÊTS MODÈLES

Our Landscape Heritage

Table of Contents

FOREWORD by Stephen R. Clayden. vii

INTRODUCTION 1

PART I: BACKGROUND TO THE ECOLOGICAL LAND CLASSIFICATION OF NEW BRUNSWICK 5

Chapter 1: The Living Landscape, Introduction and Overview. 7

Chapter 2: Landscape Awareness in New Brunswick 11

Chapter 3: Enduring Features: Geology and Topography, Climate and Soils . 21

Chapter 4: From Glacial Wilderness to a Home for Humanity. 39

Chapter 5: Ecological Gradients. 51

Chapter 6: Outline of New Brunswick Ecoregions. 71

PART II: ECOLOGICAL LAND CLASSIFICATION OF NEW BRUNSWICK: ECOREGIONS AND ECODISTRICTS 85

Plate I: Reference Map for New Brunswick Ecoregions and Ecodistricts. 89

Chapter 7: Highlands Ecoregion. 91

Chapter 8: Northern Uplands Ecoregion. 107

Chapter 9: Central Uplands Ecoregion. 141

Chapter 10: Fundy Coast Ecoregion. 181

Chapter 11: Valley Lowlands Ecoregion. 193

Chapter 12: Eastern Lowlands Ecoregion. 269

Chapter 13: Grand Lake Lowlands Ecoregion. 311

EPILOGUE 329

APPENDIX 1: Ecosites and Ecoelements. 331

APPENDIX 2: Tables of Tree Species Frequency and Abundance 341

APPENDIX 3: Species List. 347

APPENDIX 4: Bibliography. 353

Foreword

by Stephen R. Clayden

Not so many years ago, at the height of an intense controversy over logging in the Christmas Mountains of north-central New Brunswick, one of the province's veteran journalists pronounced "a big bah humbug" on the area. Its "hills are unremarkable," he wrote, and "the forests that cover them are the same mix of spruce, fir, birch and poplar found across the length and breadth of New Brunswick." I was struck by this piece. It was not the writer's weighing-in on the logging issue that caught my attention, but his view of the nature of the province's forests. This view, it seems, is a common one, and understandably so. All over New Brunswick, there are indeed mixed forests, which on casual inspection appear to vary little from one region to the next. To be sure, there are stands of pine or cedar here and there, and of course the sugar maple woods of early spring are renown. But do these local variations in the makeup of the forests follow any sort of pattern? Are some forest, or swamp, marsh, bog, or other vegetation types found consistently in one part of the province or kind of landscape, but not in others? If so, what underlies these regional and local differences?

This richly informative publication, *Our Landscape Heritage* introduces the concept of ecological land classification (ELC) in New Brunswick and describes in detail the most recently developed New Brunswick Ecological Land Classification System (NBELC). The following pages answer the absorbing questions just posed. Yet they also raise interesting new questions that emerge from the need to account for newly detected patterns. Take the distribution of poplar (*Populus tremuloides*), for example. Although it very commonly invades or regenerates in areas cleared by harvesting or forest fire, it is now clear that this species is abundant only in those parts of New Brunswick with moderate (as opposed to high) summer rainfall. Along the Fundy coast, and in the more rainy interior upland and highland areas, including (by the way) most of the Christmas Mountains, it occurs only sporadically. Is it prevented from becoming more abundant in these areas because they have a relatively low forest fire frequency and thus lack extensive open seedbed conditions? Or do the frequent summer rains maintain soil temperatures below the threshold at which root suckering occurs in poplar? Does this efficient means of vegetative spread account for the abundance of the tree in areas with warmer, drier summers? These are new questions for future research.

If New Brunswick were a uniform plain in the interior of the continent, its climate and vegetation would also lack variety. It is instead a land of rolling hills, deep river valleys, broad lowlands, and numerous lakes. It is bounded on three sides by indentations of the Atlantic Ocean, one differing strikingly from the other two in the exceptional range of its tides. These topographic and maritime contrasts bring about a significant degree of climatic variation across the province and a corresponding range of variation in its plant cover. In the highlands of the northern interior, where the growing season is shortest and coolest, and winters most frigid, boreal forests dominated by spruce and fir are prevalent. Summers are warmest in the middle Saint John River valley. More than a dozen of the tree species that prosper there are not sufficiently cold-hardy to occur in the highlands. The spruce-fir forests along the Bay of Fundy and in the highlands have much in common. However, the former forests are dominated largely by red spruce, an Appalachian and Maritime species, not by the black and white spruces of the boreal forest. These and many other trends revealed by the ELC indicate there is much more than meets the eye in the green landscapes of New Brunswick.

ELC in general is fundamentally an inventory and analysis of variation in the province's ecosystems. This variation has so far been studied mainly with reference to forests, since they dominate the landscape and create microenvironments supporting many other organisms. Where the climatic or soil tolerances of trees such as sugar maple or white pine are exceeded, then other plants, animals, fungi, and micro-organisms normally associated with the stands they form are also likely to be excluded from the landscape. On the other hand, forests occurring in widely separate but climatically similar parts of the province will tend to share many species. For example, portions of the spruce-fir forest along the Fundy coast are similar enough to those of the northern highlands to harbour isolated breeding populations of boreal songbirds such as blackpoll warblers and fox sparrows. The present document should not be seen, however, as a work relating exclusively to forests and forest inhabitants. Marshes, swamps, bogs, and other ecosystem types also vary in composition across New Brunswick. We do not yet know as much about their regional variation as we do about that of forested ecosystems, but it is reasonable to expect that more intensive study will reveal parallel trends.

The NBELC is in effect a working, evolving hypothesis. It proposes that the observed variation in the province's ecosystems can be resolved at a number of geographical scales, each reflecting the influence of a particular range of environmental factors. At the broadest scale, it proposes that this variation is controlled by major gradients of temperature and precipitation. Interestingly, this level of resolution was not evident to William Francis Ganong (1864-1941), the first ecologist to attempt a systematic classification of the province's vegetation. It is doubtful that anyone before or after Ganong has seen more of New Brunswick than he did through his marathon wilderness travels. In a paper published in 1903, he recognized fourteen different forest associations and many other non-forest groupings, each occupying, in his words, a "particular physiographic situation" (*Bulletin of the Natural History Society of New Brunswick*, No. 21, pp. 47-60). However, data on the overall distribution of these associations and on climatic variation within the province were still too limited to enable him to discern broader patterns. Significantly, he did not produce a provincial vegetation map, as the largest elements he distinguished were too small to represent at such a scale.

Almost sixty years would pass before another distinguished ecologist, Orrie L. Loucks, would elucidate the broader relationships between climate and vegetation in New Brunswick. His remarkably perceptive *A Forest Classification for the Maritime Provinces*, published in 1962, laid the foundation for the present ELC. Compared with Ganong, Loucks had much more extensive forest inventory and climatic data to work from, as well as the perspective provided by airplane travel. However, he, too, logged thousands of miles in what he described as "a detailed canvass along country roads." Where the ecoregion boundaries of the present NBELC differ from those drawn by Loucks, it is likewise on the strength of new data. Loucks, for example, recognized the area of rich hardwood forests in the middle Saint John River valley of western New Brunswick as a distinct ecoregion, on the basis of the occurrence there of basswood, butternut, and several understorey plants unknown elsewhere in the Maritimes. The climatic data available at the time suggested that these features were correlated with exceptionally warm summer temperatures. More recent data indicate that if climate were the only limiting factor, these species could potentially occur through much of southern New Brunswick and in parts of Nova Scotia. The NBELC thus revises Loucks's hypothesis, proposing that the restriction of basswood and butternut to western New Brunswick is related to their requirement for lime-rich soils. The lack of such conditions over most of southeastern New Brunswick may have acted historically as a barrier to the dispersal of these trees, and some of their associated species, into Nova Scotia.

The most far-reaching practical consequence of the NBELC-view of the landscape is that it has provided the framework, and much of the impetus, for developing a system of protected areas representative of the regional natural diversity of New Brunswick. The boundaries of these areas have been and will be hard won. Every part of the province has a history of more or less intensive land use. Forgoing or limiting these traditional uses entails sacrifices, but it can also bring considerable rewards. As that seasoned land-surveyor Henry David Thoreau observed, we are enriched in proportion to the number of things we can afford to leave alone. Since we now have the means to alter any and all of the remaining relatively wild natural landscapes of the province, the decision to set aside and protect some of these special places becomes a creative, not a restrictive act, an expression of our deeply held cultural values.

The current view of ecological patterns in New Brunswick presented in this publication is the outcome of an impressive scientific and creative collaboration over the past few decades. Ecologists, geologists, soil scientists, botanists, climatologists, cartographers, naturalists and educators have contributed to make this an indispensable guide to the province. Even for those already well acquainted with the landscapes here, it will shed new light on familiar places and regions, and provide a framework linking the province's climatic, geological and biological diversity. It will whet the appetite of any outdoors traveller to explore more widely and observe more closely the richly textured natural fabric of New Brunswick.

The Goose River empties into the Bay of Fundy. Fundy Coast Ecoregion.

Introduction

Purpose of this book

This book provides an overview of the history and ecological makeup of the landscapes of New Brunswick to help ecological seekers starting out with basic knowledge about geology, soils, climate, and vegetation, to better understand why plants and animals are today distributed as they are. This book will provide not only a *view from the mountaintop* that puts New Brunswick in a North American context, but will also provide the reader with the ability to see their back yard or their own woodlot in a new light. We hope that some who use this Ecological Land Classification (ELC) will be driven by curiosity about the natural world to generate new knowledge and insights. But most of all we hope this intimate look at our province's ecosystems will motivate readers to become better stewards of New Brunswick lands, and help others to become likewise engaged in living consciously, deliberately, and with care alongside New Brunswick's natural heritage.

How to Use This Book

Readers seeking information about ELC, including its history and application in New Brunswick, information about data sources, descriptions about natural phenomena that influence ecosystems in our region, and explanations about concepts underlying the classification will find this information in the six chapters that make up Part I, *Background to the Ecological Land Classification of New Brunswick*.

Other readers seeking descriptions of local areas may go directly to Part II, *Portrait of New Brunswick Ecoregions and Ecodistricts*.

Readers possessing specialized knowledge about forest soils and plants will find useful tools for classification at fine scales in Appendix I: *Ecosites and Elements,* and in Appendix II: *Tree Species Selection Tables.*

Outline of Part I

Part I, *Background to the Ecological Land Classification of New Brunswick* encompasses chapters 1 through 6 and outlines the rationale and history of ELC in New Brunswick, and presents basic scientific concepts and facts that help the reader to interpret the information that follows.

Chapter 1, *The Living Landscape*, presents a mixture of facts and philosophy that describe the aims of ELC .

Chapter 2, *Evolution of Landscape Awareness and Classification in New Brunswick*, highlights from early times through the present the notable contributions of scientists, naturalists, and native elders from New Brunswick to the modern ecological synthesis presented in this document. A basic outline of the New Brunswick ELC and methodology used to derive it is also presented here.

Chapter 3, *The Enduring Features: Geology and Topography, Climate and Soils* provides background on the ways in which the enduring features of New Brunswick's landscape, including landscape, rocks and soils, and their interaction with climate, create the varieties of ecological conditions that occur.

Chapter 4, *From Glacial Wilderness to a Home for Humanity* briefly looks at the last several millennia by very briefly outlining the effects of climatic changes, natural disturbances, and human activities since the time of the glaciers on the current pattern of flora and fauna. It ends with an assessment of more recent past history and the effects on the environment brought on by human migrations to North America and the rise of industrial society. Past events whether triggered by climate change or human activity are major determinants of the "look of the land" today.

Chapter 5, *Ecological Gradients*, introduces the concept of ecological gradients and explores the specifics regarding how they affect species and ecosystem distribution at several scales.

Chapter 6, *Outline of New Brunswick Ecoregions*, builds on the previous chapters to explore the patterns of distribution of ecosystems and species relative to the boundaries of New Brunswick's ecoregions.

Outline of Part II

Part II, *Portrait of New Brunswick Ecoregions and Ecodistricts* presents a detailed look at the variety and distribution of ecosystems across the geographic expanse of New Brunswick. Each of the seven chapters of Part II provides a high level description of the ecoregion, followed by detailed descriptions of each ecodistrict within the ecoregion.

Finding Information About a Specific Area

Refer to the introductory pages of Part II (p. 85), and to Plate I (p. 89) to locate a New Brunswick community with regard to its ecoregion or ecodistrict.

For more Information

Contact the Department of Natural Resources.

By mail:
Director of Communications
Department of Natural Resources
P.O. Box 6000
Fredericton, New Brunswick
E3B 5H1

Telephone:
(506) 453-2207

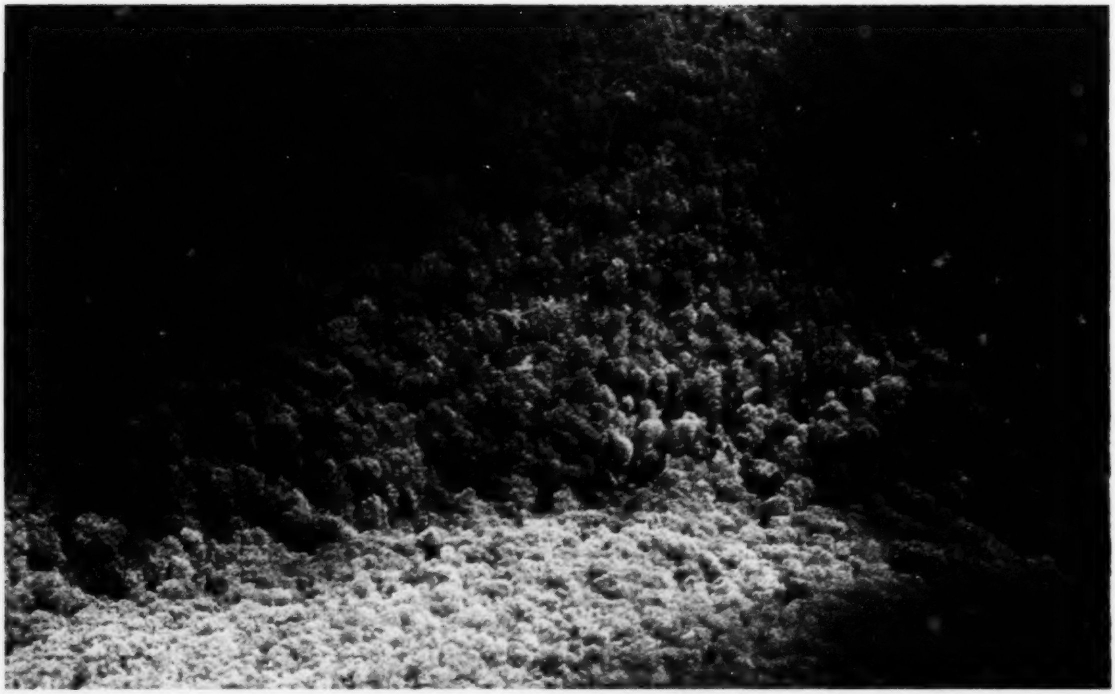
Internet:
http://www.gnb.ca/0078/index-e.asp

By email:
dnrweb@gnb.ca

PART I

BACKGROUND TO THE ECOLOGICAL LAND CLASSIFICATION OF NEW BRUNSWICK

... where the history and rationale of ELC in New Brunswick is outlined, and scientific concepts and facts that help the reader to interpret Part II are presented ...



A steep-sided valley is covered with luxuriant mixed conifer and hardwood forest cover that obscures the stream flowing through, northern New Brunswick.

Chapter 1

The Living Landscape

The New Brunswick landscape presents a dynamic blend of contrasting features that give it a character unlike any other in Canada. To the north rises Mount Carleton, the tallest peak in the Maritimes. To the south, the world's highest tides surge through the Bay of Fundy. Between the mountains and the sea lie churning rivers, sparkling lakes, vast wetlands, and fragrant forests alongside fields and mud flats shimmering with bird life. New Brunswick's human residents have lived for many centuries under the direct and indirect influences of the landscape. Aboriginals and European immigrants preferred to inhabit sheltered coastal areas and river valleys rather than windswept highlands. Farming hamlets evolved in zones of arable soil, while forestry and mining towns emerged in districts of timber and mineral riches. New Brunswick's major river systems served as highways for canoes and steamboats, and engineers designed their roads and railways around landforms whose topography reflected the underlying geology.

Most of us have heard that repeated disturbances by fire and insects such as the spruce budworm have had an important effect on where the different species of plants and animals are found in New Brunswick. Less well known is that the various elements of New Brunswick's landscape—its variety of rock types, soils, regional and local climates and 'lay of the land'—have at least an equally important effect on what species live where, and why. This is true not just for human populations, but also for the myriad species of provincial fauna and flora. The understorey vegetation enriching the boreal forests on Mount Carleton, for instance, is very unlike that found by the languid and fertile banks of the lower Saint John River. The bird life along the Bay of Fundy coastline differs markedly from that surrounding the shores of Grand Lake.

Interestingly, it has been suggested that landscape—for human beings, at least—not only determines who lives where, but also has a profound affect on who we are. It seems true that an appreciation of one's local landscape generally enables a person to feel more connected to the place he or she calls home.

As well, importantly, an awareness of landscape—its biological diversity, its habitat fragility, the interconnectedness of its elements—can help us make informed decisions on land use and conservation within our local communities. For just as landscape has influenced our socioeconomic development, so have human activities come to significantly affect the landscape. New Brunswick's population has risen by 45% since the 1950s, and the interplay between landscape preservation and land use is more challenging now than ever before.

The Need for Stewardship

In 1968, Apollo 8 beamed the first-ever space photographs of the earth back to an astonished human audience. As we looked at those first images from space of the fragile planet, many of us were reminded of the earth's interconnectedness and the need to be effective stewards. Canadian astronaut Roberta Bondar reflected on her experience of viewing the earth from the space shuttle in January of 1992:

"My impression is that each crew member lives and relives Earthviewing in an extremely personal manner, some challenged spiritually or intellectually more than others by the contrast between the black universe and the bright pastel Earth. Many questions arise when you are removed from your preflight, Earthbound mindset and

faced with the reality that there is nothing else around you but black, inhospitable space."

For many of us, viewing the biosphere from the outside has had a strong impact on our perception of the value and preciousness of life as we know it, and of the fragility of the planet. As Bondar further elaborates in *Touching the Earth*, the view from space has helped to bring into focus the human-caused changes to the biosphere of the last thirty years.

The earth as seen from the moon's orbit by the crew of Apollo 8, on Christmas Day in 1968. *Photograph courtesy of NASA*

It is also clear that addressing stewardship, land-use decisions and other sustainability issues requires more than good intentions or esoteric values. It demands hard data that can be used to define ecosystems in ways that will better help us to understand and conserve ecological processes. For it is through such processes that the Earth creates the possibility of life, our own and that of the estimated 30,000 other species with whom we share this province. And it is factors such as climate, soil, and landscape history that together influence an ecosystem's composition in terms of what species live there within it.

Put another way, we need to know who or what lives where, and why they live there, so as to predict, and better manage the effect of various activities including forestry, mining, agriculture, community and industrial development, tourism and recreation.

What is Ecological Land Classification?

An ecological land classification system (ELC) is a way of recognizing and describing ecosystems at various spatial scales—from very broad and large ecological zones covering a large piece of the continent, to very small, localized microsites. ELC uses features of the physical environment, including temperature, precipitation, topography, soil type and other biophysical attributes. The purpose of ELC is to divide and categorize ecosystems into similar and dissimilar pieces at various scales. ELC can provide information that will allow for better predictions and analyses of phenomena related to forestry, conservation, wildlife management, and other land-use decisions than could be obtained simply by observing trees, other plants, and animals in isolation.

Scientists sometimes use the term 'ecosystem' in reference primarily to communities of interacting plants or animals or species or groups, excluding their biophysical or geographic context. In this document, that order of priority is reversed, and the enduring, physical features are given primary consideration in delineation of ecosystems. This approach, rooted in geography and describing relatively static earth, air, and water spaces on the globe, avoids the pitfalls of defining ecosystems using mobile and dynamic plants and animals. When looked at this way, the concept of ecosystems becomes more tangible and operationally useful for a range of objectives. The eminent Canadian ecologist Stan Rowe once described an ecosystem in similar theoretical terms as "a giant terrarium or aquarium in which all life forms live and all human activity takes place."

Given our changing view of the earth and its ecosystems as interdependent parts of a larger whole, how will New Brunswickers meet the environmental challenges that face us? More and more of the new generation of our province's farmers, fishers, woods workers, professional experts, and ordinary citizens are embracing this more strongly grounded, local ecosystem-based image of their home. As they renew their calling to be effective environmental stewards, they feel a need to know more about their landscape heritage. This book aims to fill some of that need.

Why is this northern New Brunswick landscape dominated by coniferous forest? Ecological land classification can help provide insight into such questions.

A field ecologist observes and records the occurrence of plant species and ecosystem conditions, and keeps alive a tradition that is at least as old as human habitation in the Maritimes.

Chapter 2

Landscape Awareness in New Brunswick

Recent interpretations of human history suggest that change in a civilization's fortunes is often related to environmental awareness, or a lack of it, leading to changes in the conditions that sustain that civilization. In this chapter, we briefly trace the changes in landscape awareness in New Brunswick over time and identify how those changes affected the evolution of ecological classification in the province.

Earliest Landscape Awareness

Awareness of and respect for the variation of natural landscape in the Maritimes was a foundation of life among the aboriginal people who first inhabited the territory. They recognized how different landscapes provided a variety of food sources, and learned to predict the most likely habitats for wild game, fish, shellfish, and edible and medicinal plants. They secured cranberries for sustenance, sugar maple for sap, and sweet grass for ceremonies, knowing that cranberry, maple and sweet grass could be found in bog, hillside and marshland, respectively.

The major drainage systems of New Brunswick (the Miramichi, the Restigouche, the Saint John and other rivers) were well known and used as canoe routes by the Passamaquoddy, Mi'kmaq and Maliseet First Nations. Some of these watersheds became *de facto* loose territorial boundaries. The Maliseet tended to remain in the north and west, moving extensively along the Saint John and Tobique river systems, whereas the Passamaquoddy frequented the southwest coastline. The Mi'kmaq preferred the eastern lands and have divided the Maritimes into seven traditional districts based roughly upon watershed and other geographic considerations.

The dominant North American culture customarily thinks of the 'march of scientific progress' as a story of continuous advancement. However, losses of scientific knowledge have occurred. For example, written history has recorded little about the many of the great travellers, innovators, and herbalists from the First Nations. Not only is it difficult to retrieve this kind of information, but basic facts about the traditional First Nations view of the land and its resources remain to be learned. Except individuals fully immersed in aboriginal language and culture, it is difficult to fully appreciate how traditional aboriginal people thought about their surroundings and the environment. Evidence of the store of practical knowledge they possessed comes to us in the well known stories of how aboriginal people taught early colonists from Europe to overcome the challenges of life in unfamiliar surroundings. Further striking differences in perspectives and knowledge go beyond these practical considerations to encompass foundational outlook and spiritual perspectives – perspectives that are beyond the scope of this book. Today, many individuals are making efforts to learn and record for future generations the wisdom of the elders of the Maritime First Nations.

Members of the Maliseet First Nation at Kingsclear celebrating Corpus Christi Day, *c.* 1887. *Photograph courtesy of the Provincial Archives of New Brunswick.*

First Europeans

In the 1500s and early 1600s, European explorers made their first detailed investigations of what would later be called New Brunswick. In these excursions, they sought evidence of abundant natural resources that would ensure continued support from their royal benefactors back home. Louis Hébert, an apothecary from

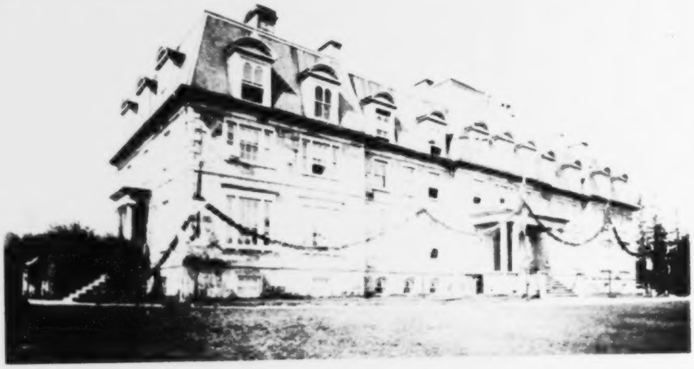
Paris who accompanied Champlain to the region in the early 1600s, investigated the lower Saint John River and made perhaps the first European reference to that valley's rich growth of butternut, wild grape, beech and oak. The famous trader and explorer Nicolas Denys lived in the Bathurst area during the 1680s and wrote lengthy descriptions of the trees and plants of coastal Acadia in his book on the natural history of North America.

The Royal seal of the colony of New Brunswick. Provincial Archives of New Brunswick.

Until the 1800s, these and other European efforts at recounting the natural splendours of New Brunswick leaned heavily on the side of eclectic, if exuberant, annotations with little by way of systematic record keeping or ecological interpretation. In large part, they focused on the assessment of lumber, mineral, and wildlife resources for their economic potential. Indeed, New Brunswickers at the turn of the 19th century tended to regard the forests as a source of timber and quick wealth – a fact not lost on the government official Moses Perley who, in his 1847 *Report on the Forest Trees of New Brunswick*, deplored the "wanton and unprofitable waste and destruction" of red pine, caused by the "greediness and improvidence of the lumbermen." Perley's report was designed primarily to inform colonial settlers about the practical use of tree species. At the same time, it provided some anecdotal data on the distribution pattern of these species, occasionally noting their preferred habitat and growing conditions. It also revealed interesting tidbits not usually encountered in forestry reports, such as: "Cattle eat the leaves of the [white] ash greedily, but they are said to give a bad flavour to the butter."

It was not until the establishment of Kings College (now the University of New Brunswick) in 1829 that natural sciences achieved sufficient local respectability to encourage the tentative beginnings of rigorous plant collecting, geological observation, and analysis of the provincial landscape. Fieldwork associated with these and later 19th century studies involved the collection of data that subsequently formed the basis of New Brunswick's ecological land classification system.

Kings College, c. 1900. This structure is now the Old Arts Building on the campus of the University of New Brunswick in Fredericton. *Photograph courtesy of the Provincial Archives of New Brunswick.*



First Plant Collections

The first person to initiate systematic plant collecting in New Brunswick was James Robb, a professor of Natural Science and Chemistry at Kings College. In 1838, Robb made a lengthy field trip up the Saint John, Tobique and Grande rivers, where he gathered a sizeable number of plant specimens.

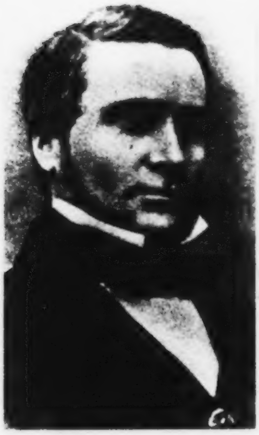
Robb's successor at the college was Loring Bailey, a popular professor who later introduced electricity and the phonograph to Fredericton. In 1863, early in his Kings College career, Bailey took a canoe expedition up the Tobique and across the watershed divide to the Nepisiguit River to gather information on geology and botany. He noted how the vegetation changed as he ascended Sagamook Mountain but did not specifically attribute this phenomenon to the climatic and soil shifts associated with increased elevation.

Bailey was only one of several early New Brunswick geologists to undertake plant collection in the mid-1800s as a sideline to their major scientific pursuit. Another was George Frederick Matthew, a Saint John customs collector who became one of the most noted geologists and fossil collectors of his day.

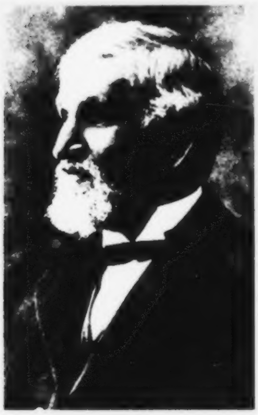
Matthew assembled an herbarium of some 3000 plant species, and, in 1869, he wrote a significant paper on the arctic plants of New Brunswick, describing the connection between alpine plants in the mountains of New England and alpine vegetation along the Fundy coast of New Brunswick. He attributed the anomalous arctic populations in New Brunswick to the "cool vapor bath of sea fogs" from the Bay of Fundy that produced conditions more commonly associated with land situated several thousand metres above sea level. His prescient conclusions foreshadowed the subsequent delineation of New Brunswick's Fundy Coast Ecoregion.

Even as Matthew penned the finishing touches to his 1869 paper, a self-taught botanist named Reverend James Fowler was hard at work compiling additional information on New Brunswick plant life. A native of Bass River in Kent County, Fowler taught science at the Fredericton Normal School, but devoted his spare time to plant collecting. He published the first extensive catalogue of New Brunswick plants in 1885, five years after leaving the province to instruct botany at Queen's University in Ontario.

Although Fowler took much of his collection with him, he left behind a small, but inspired, group of students who continued collecting around the province. The dedicated exertions of these and other New Brunswickers such as Philip Cox and George Hay, were



James Robb, c. 1840. *Photograph courtesy of the Harriet Irving Library Archives, University of New Brunswick .*



Loring W. Bailey, c. 1890. *Photo courtesy of the Harriet Irving Library Archives, University of New Brunswick.*

George Frederick Matthew, c. 1870. *Photo courtesy of the Harriet Irving Library Archives, University of New Brunswick.*

much in keeping with the Victorian passion for amateur scientific outings that so characterized the leisured (and sometimes not so leisured) classes of the late 1800s.

Beginnings of Ecology

By the end of the 19th century, much had been accomplished by way of provincial plant collections and field observations. A general awareness existed of the diversity and distribution patterns of plants, and tentative efforts had been made, as with Matthew's paper on arctic plants, to draw conclusions from localized observations. Yet no one had produced a broad provincial synthesis of the data or attempted to relate the ecological implications of plant assemblages and their associations with climate, soils, and geology.

In fact, ecology as a formal academic discipline did not emerge in earnest until the turn of the 20th century in Germany. One of the first people to apply ecological principles to New Brunswick's scientific arena was the scholar, botanist, naturalist and historian extraordinaire, William Francis Ganong.

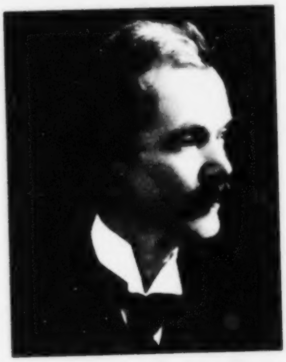
Ganong completed his Ph.D. at the University of Munich in 1894 and went on to publish the first of his *Contributions to the Ecological Plant Geography of New Brunswick*. His 1903 paper on the ecology of salt marshes in the Bay of Fundy was remarkable for its day and, even now, is considered a classic by wetland ecologists. Ganong also authored a steady series of papers describing the natural history and landscape character of New Brunswick.

Yet for all his monumental contribution to the natural and cultural history of the province (as one recent biographer so aptly wrote, "the man invites superlatives"). Ganong never actually placed the decades' worth of plant collection and other data in a regional climatic context. He proposed instead a classification system defined by physiography and habitat, using soil and hydrology as the main criteria.

Ganong thus travelled partway down the road towards the present ecological land classification system but became sidetracked, as it were, by alternate approaches and considerations... not to mention his other, equally valuable scientific and historical pursuits.

Methods of quantitative ecology and ecological classification underwent considerable refinement in the first half of the 20th century, at least partly in recognition of the importance of natural

Reverend James Fowler, c. 1890. *Photo courtesy of the Harriet Irving Library Archives, University of New Brunswick.*



George Hay, ca 1890. *Photo courtesy of the Harriet Irving Library Archives, University of New Brunswick.*

William Francis Ganong, c. 1890. *Photo courtesy of the Harriet Irving Library Archives, University of New Brunswick.*

resources to economic development. In particular, there were concerns about the increased demand for timber, its rapid rate of depletion, and the need to manage what was left. Scientists developed a number of forest-based classification systems for North America that relied on combinations of climate, indicator plants species, and physiographic boundaries. These systems were designed less for biological conservation purposes than to establish a predictable basis for increasing the yields of commercially valuable plants and animals, as was already common practice in agriculture.

The most significant of these classification efforts in New Brunswick involved the work of a research scientist named Orrie L. Loucks who, in 1962, published the definitive and catalytic report entitled *A Forest Classification for the Maritime Provinces*. Loucks's system integrated a variety of criteria including forest cover, climate, landform, geology, and soils, and essentially it became the forerunner of the modern ecological land classification system for New Brunswick. He defined seven forest zones for the Maritimes and subdivided them into ecoregions and site districts. The boundaries of Loucks's regions and districts in most cases closely parallel those of the ecoregions and ecodistricts described in this document.

Orrie L. Loucks, in Fredericton, 1956. *Photograph courtesy of O.L. Loucks.*

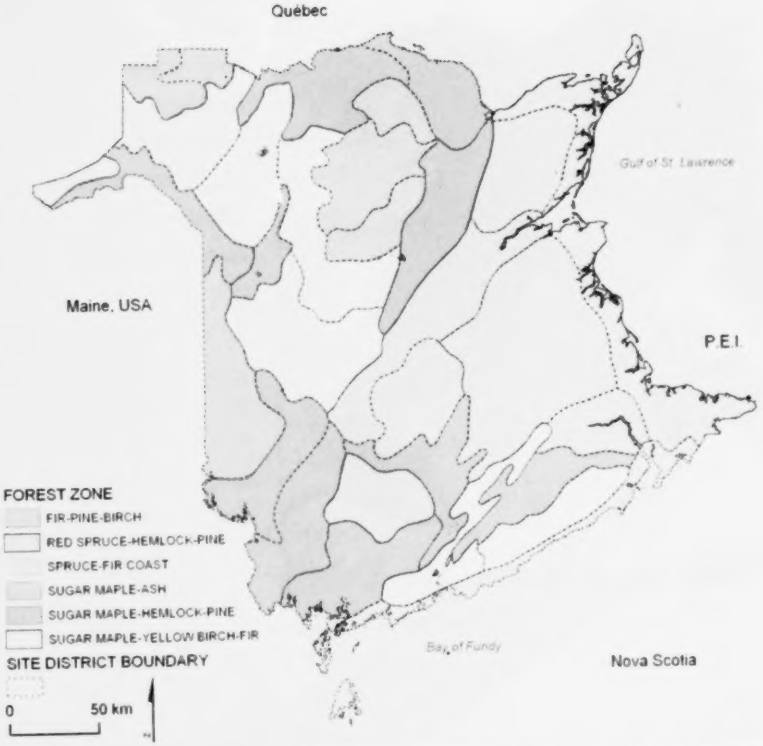
Ecological Land Classification Today

The decades between the 1962 publication of Loucks's report and the mid-1990s creation of New Brunswick's Ecological Land Classification System (NBELC) saw several events that contributed to the development of New Brunswick's present ELC framework.

The Canada Land Inventory (CLI) of the 1960s and 1970s was a major exercise in data gathering, mapping, and interpretation of the potential uses of Canada's rural landscapes. Interpretation categories included forestry, agriculture, recreation, and wildlife. The world's first functional geographic information system (GIS) — a computer-based system for storing and handling maps and associated data — was developed for the CLI.

The CLI was a precursor to the Canadian Ecological Land

Classification System (CELCS), which was devised in the 1970s. It integrated factors related to climate, terrain, soil, water, and wildlife habitat into a multi-level framework. The intent of this federal and provincial initiative was to use the inventory for scientific research, sectoral reporting, land-use planning, resource management, and environmental education. The CELCS encompassed many ecological scales ranging from the very broad (such as the ecozone, which could span several provinces) to the very detailed (such as the ecoelement, which might be the size of a flower garden). It provided a uniform ecological approach to land classification and was adopted as the model for New Brunswick's ecological land classification system in the 1990s.


Québec
Gulf of St. Lawrence
Maine. USA
P.E.I.
FOREST ZONE
FIR-PINE-BIRCH
RED SPRUCE-HEMLOCK-PINE
SPRUCE-FIR COAST
SUGAR MAPLE-ASH
SUGAR MAPLE-HEMLOCK-PINE
SUGAR MAPLE-YELLOW BIRCH-FIR
SITE DISTRICT BOUNDARY
0
50 km
Bay of Fundy
Nova Scotia

Ecological map of New Brunswick (after Loucks 1962). Forest Zones are named for the forest composition of a 'zonal site', defined as a midslope southern aspect with deep soils of medium texture.

In the 1980s, the concept of an ecologically based forest site classification was emerging among a diverse group of provincial and federal foresters, soil scientists, ecologists, and geologists. A number of projects were initiated to explore the relationship between ecosystem character and the growth of forest stands and trees.

Of note was the novel approach to soil classification championed by A.A. (Art) Ruitenberg, a geologist with the New Brunswick Department of Natural Resources (DNR), and Herman vanGroenewoud, a research scientist with the Canadian Forest Service who, during his career, also pioneered advanced mathematically-based ecological data analysis techniques. The traditional approach to soil classification and mapping emphasized features of importance to agricultural potential, and gave little consideration to steep, swampy, and stony forested areas that make up so much of the non-agricultural land base. The Ruitenberg-

Herman vanGroenewoud in 1975. *Photograph courtesy of the Canadian Forest Service.*

A.A. "Art" Ruitenberg in 1981.. *Photo courtesy of A.A. Ruitenberg*.

vanGroenewoud approach emphasized evaluation of nutrient sources inherent in the natural mix of rock fragments that make up the soil parent materials and was therefore well suited to the mapping of wildlands.

Ruitenberg demonstrated, promoted, and passionately defended, his understanding of the relationship between the chemical and physical composition of rocks that make up the soil, and relating these characteristics to ecosystem productivity and tree growth. The geological emphasis on soil assessment advanced by Ruitenberg was embraced by ecologists and foresters working in the field, and opened up extensive libraries of existing geological maps for use in forestry. It was found to be useful beyond predicting rates of tree growth. Ecologists noted that forest ecosystem species composition in New Brunswick were strongly related to soil type as described by the system.

During the 1990s, land classification broadened its narrow focus on timber and resource productivity to address non-forested ecosystems such as wetlands, as well as biological diversity and land-use issues.

Framework of the Present Ecological Land Classification

The NBELC described in this book is a refinement and an expansion of diverse ecosystem mapping and description projects which were dovetailed into a working prototype in 1994. This work was expanded in a 1996 draft report prepared by DNR; it is entitled *An Ecological Land Classification System for New Brunswick*. The document defines the ecoregion, ecodistrict, and ecosite levels based on the methods and terminology recommended by the Canadian Committee on Ecological Land Classification.

To date, the NBELC and its precursors have been used in protected areas planning to characterize representative landscape types and to locate rare forest types and other distinctive habitats that may require special management or protection. In forest management, they have been used to predict stand growth, to predict vegetation response to disturbance, in planning forest management that addresses biodiversity concerns, and to facilitate timber inventory.

The delineation process for the NBELC involved studying New Brunswick's range of variation in climate, landform, geology, hydrology and soils, and correlating these data with the distribution of plants, plant communities and, to a lesser degree, animals. Ecological units are delineated from the top down, beginning at the ecoregion scale and proceeding down to ecosection.

NBELC Classification Levels

Ecoregions are defined primarily by climate, as shaped by major landforms, latitude, elevation, marine influences, and broad aspect (see Chapter 6). Ecodistricts conform to major breaks in predominant rock type, glacial deposit type, relief, or elevation. They in turn are subdivided into ecosections by being split into terrain roughness categories.

The delineation at each level has been validated or refined using information on the geographic distribution patterns of indicator plant species, forest stand types, wetlands or wetland types, or trees species.

Ecoelements describe a fine scale (generally less than 5 ha) topographic, geological, and soil environment for which the predominant vegetation type is predictable from the study of regional patterns (see Appendix I). Soil moisture regime, soil nutrient

Levels, criteria, biological indicators, and sources of data for the New Brunswick Ecological Land Classification System.

Level of Classification	Criteria	Biological Indicators	Sources of Data
Ecoregion	Macroclimate as shaped by elevation, broad scale aspect, proximity to marine climatic influences	Proportions of needle-leaved and broad-leaved forest on reference sites	Regional sources of climatic data (Dzikowski et al., 1984) Topographic maps (1:500,000 scale) Data describing marine climatic effects
Ecodistrict	Geomorphology and geology	Tree species composition on reference sites	Topographic maps (1:250,000 scale) Physiographic regions (Bostok 1970) Forest Soils of New Brunswick (Colpitts et al. 1995)
Ecosection	Landforms; patterns of branching of watercourses; type of glacial deposit	Pattern and extent of plant associations	Topographic maps (1:250,000 scale) Forest Soils of New Brunswick (Colpitts et al. 1995)
Ecosite	Topoclimate; type of soil deposit	Plant species composition	Topographic maps (1:50,000 scale) and orthophotos (1:10,000 scale) Forest Soils of New Brunswick (Colpitts et al. 1995)
Ecoelement	Microclimate; soil moisture, and nutrients	Plant indicators of microclimate, moisture, and nutrient regime	Ground reconnaissance; very detailed aerial photography; high-resolution digital elevation data

regime, and microclimate are the defining criteria of ecoelements. Field keys employing soil and plant indicators have also been developed. Many ecoelement types are familiar to casual observers, such as sugar maple ridges, spruce-dominated flats or valleys, and black spruce swamps and bogs. Ecosites are localized groupings of ecoelements outlined at a broader mapping scale. Often there is more than one ecoelement in an area mapped as a single ecosite. In these cases ecosites are named for the predominant ecoelement within the mapped area.

Field ecologists mapped the ecosites of New Brunswick using computer-based data analysis, supplemented by the judgement acquired through previous field work, as follows. Each of the roughly one million stands in the DNR Forest Development Survey was classified into one of eight forest types according to the main tree species or species group it contained. The forest types included black spruce, jack pine, other pine, mixed spruce-fir, pure balsam fir, mixed coniferous and tolerant hardwood, eastern white cedar, and pure tolerant hardwood.

The field ecologists then used computers to associate each stand with its corresponding ecoregion, ecodistrict, and ecosection, plus its soil type, elevation class, and slope class from other maps. This formidable task was made manageable by specialized, powerful map-handling computer software (geographic information systems).

These stand-soil-topographic data were then analyzed with ecological data analysis software to evaluate how enduring features correspond with the patterns of natural forest vegetation in each ecosection. Guided by this analysis and by field experience, the ecologists then classified the many hundreds of possible combinations of soil, geology, and topography into a smaller number of ecosites, based on the similarity of their enduring features and the best fit of the enduring features with vegetation. Ecosite maps are the end product of this process.

Conclusion

In this chapter we have briefly introduced the best known contributors to the knowledge of our landscape heritage, and in so doing we have shown the path from the early natural historians and naturalists to the present NBELCS. In Chapter 3, we will begin an examination of the enduring features of the ecosystem (geology, topography, climate and soil) that underlie and explain much about the character and species composition of ecosystems in New Brunswick.

Geology, topography, climate, and soils are influential on ecosystem character.

Chapter 3

Enduring Features: Geology and Topography, Climate and Soil

The enduring features of a landscape – geology and topography, climate and soils – lend themselves readily to sensory impression. A person can feel hard bedrock underfoot, smell damp forest soil on an upturned tree root, or sense an icy wind or warm rain on the face. A practical aspect of ecological land classification is that it uses tangible physical features and measurable climatic phenomena to describe ecosystems.

Each enduring feature melds into the other in a continuum of interaction. Soils are derived partially from the action of climatic elements upon rock as the sun, wind, ice, and water take their toll on stone, hastening its physical and chemical degradation into soil particles. Geology and glaciation help to sculpt the topography of a landscape. Topography is decisive in creating climate through such factors as the relationship between temperature and elevation.

As noted in Chapter 1, the relative influence of these enduring features depends upon the geographic scale of observation. Together, the enduring or non-living features provide the more or less stable environment in which the biotic elements of fauna and flora exist.

Geology and Topography

Geology is arguably the most fundamental of all the enduring landscape features. Bedrock creates the structure beneath the countenance of landscape, although weathering and glaciation do much to soften and alter its face – that is, to modify its physiography or topography.

The rocks of New Brunswick belong to the Appalachian Mountain Range, which borders the Canadian Shield that forms the core of North America. The Appalachians reach from central Alabama northeast to Newfoundland and were continuous with the Caledonides Mountain Range in northwest Europe until the two ranges became severed with the opening of the present Atlantic Ocean some 200 million years ago. As an example of this ancient marriage, a person walking in areas of west Saint John will encounter outcrops that belong to the same volcanic rock sequence as those seen by a hiker on the cliffs of St. David's Head in southwest Wales.

Geology with a Past

The rocks of New Brunswick cover a time period of about one billion years between the oldest rocks around Saint John and the youngest strata on Grand Manan Island. The time spans involved in geological reckoning have led to the development of a time scale with eras and periods covering millions of years.

New Brunswick's geological evolution has involved turbulent episodes of volcanism, tectonic rifting, continental collision, and mountain building, interspersed with unimaginably lengthy interludes of relative quiescence, drifting sedimentation, and gradual erosion.

Current geological thinking suggests the story began about one billion years ago when the world was already 3.6 billion years old, and the continents as we know them did not exist. Instead, there appears to have been a giant supercontinent that shifted about the planet before slowly breaking into tectonic plates or protocontinents around 600 million years ago. These plates can be thought of as rock islands floating on a sea of molten rock inside the earth's crust.

For another several hundred million years, the plates skimmed the globe, driven by intense heat and convection currents beneath earth's crust. Their movements resembled a very slow geological dance in which the plates repeatedly drifted apart and then collided with each other over time. The boundaries of plate separation changed with each opening and closing so that the resulting continents, including the region we now call New Brunswick, became a geo-montage of rocks of varying ages and type.

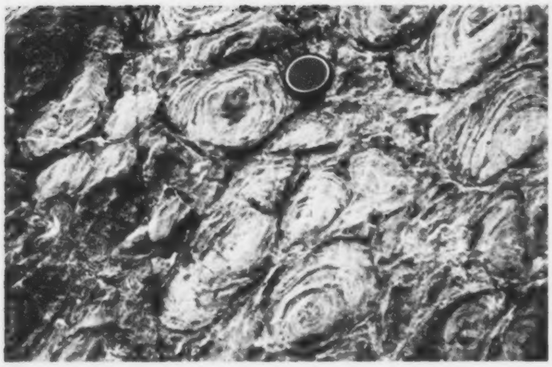
As the continental plates separated, whole oceans developed between them, and sediments eroding from the continents filled huge valleys beneath the expanding sea. In places where the plates merged together and the oceans closed, volcanoes erupted, and buckling mountains formed at plate margins. The mountainous edge of the west coast of the Americas is relatively youthful geologically, and reflects this process. Ordovician volcanic rocks from an early episode of ocean closure can be seen near Bathurst, where they are mined for their base-metal deposits. The earth of one billion years ago was a younger, internally hotter, more volcanic place than it is today.

The geological time scale.

Eon	Era	Period	Millions of Years Ago	Event
Phanerozoic	Cenozoic	Quaternary	24 to 1.8	Glaciation; first humans; modern mammals evolve; first grass
		Tertiary	65 to 24	
	Mesozoic	Cretaceous	142 to 65	Extinction of dinosaurs; first flowering plants
		Jurassic	200 to 142	First birds, dinosaurs prominent
		Triassic	248 to 200	First mammals and dinosaurs
	Paleozoic	Permian	290 to 248	Reptiles dominant
		Carboniferous	362 to 290	Extensive coal forming swamps; first reptiles and ferns
		Devonian	418 to 362	First trees; fish dominant; first amphibians
		Silurian	443 to 418	First sharks
		Ordovician	495 to 443	First land plants; invertebrates dominant
		Cambrian	545 to 495	First fish; diversification of invertebrates
Precambrian	Proterozoic		2500 to 545	First multicellular life; oxygenation of the atmosphere
	Archean		4000 to 2500	First unicellular life
	protogeological history of the earth		4600 to 4000	Intense meteor bombardment of the earth; oldest known rocks formed at the end of this era

The Fossil Record

Some of the oldest known rocks in New Brunswick are Late Precambrian limestones that were deposited during an early period of ocean opening. These rocks occur near Saint John and hold ancient fossils known as stromatolites, remnants of algal reefs that lived some 980 million years ago. During the Late Cambrian, New Brunswick's fossil record reveals evidence of more advanced life forms, including oval-shaped creatures called trilobites that resembled horseshoe crabs, and brachiopods that looked somewhat like bivalve molluscs.



A camera lens cap provides a reference scale for fossil stromatolites located near Saint John. Photo courtesy of the *New Brunswick Museum*.

When the ancient oceans closed yet again during the Devonian, about 400 million years ago, molten rock that would later become massive bodies of granite called plutons intruded the older rocks. The resistant granitic plutons were less easily eroded than some of the surrounding rock types and today form areas of high elevation, such as the Christmas Mountains. Devonian granites in New Brunswick have been quarried for dimension stone and aggregate material and contain significant metallic minerals.

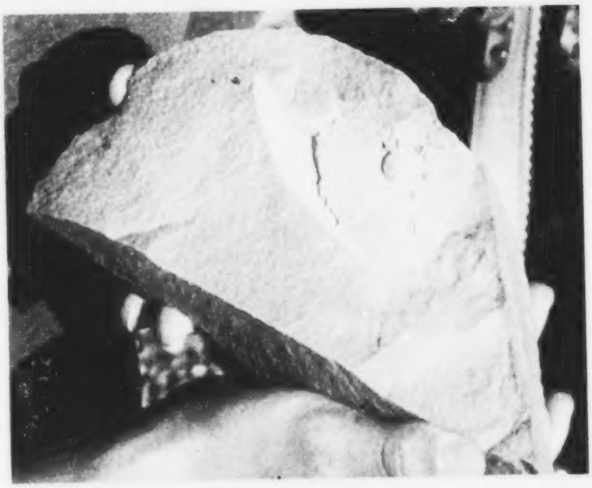
Elsewhere in Devonian New Brunswick, future uplands were being deposited on the ocean floor from older, eroded material. These sedimentary rocks preserved the oldest vertebrate fossil in the province: a jawless fish, *Yvonaspis campbelltonensis*, so-named for its discovery location in northern New Brunswick near Campbellton. This extinct fish lived about 350 to 400 million years ago, had one central nostril between its eyes, and featured a protective sensor zone along the edge of its head shield.

A fossil trilobite from the New Brunswick Museum collection. Photo courtesy of the *New Brunswick Museum photo.*

About 370 million years ago, the nearly half a billion years of tectonic jostling subsided into a relatively tranquil era that spanned much of the Carboniferous and Permian. The land that became New Brunswick lay near the present-day equator at this time, and a shallow sea invaded the land.

Terrestrial or land-based plants, which had first appeared in the Silurian, came into their own during this humid time and grew in profusion across the Carboniferous landscape. One of the most interesting was a huge tree-like plant called *Calamites*. The Carboniferous also saw massive volumes of sediment eroded from mountain ranges to the west and transported by river systems to form huge deposits of sand, gravel, and clay. The sediments eventually consolidated into the sandstones, conglomerates, and shales that comprise the huge wedge of Carboniferous strata blanketing central and eastern New Brunswick.

A final episode of continental rifting began in the Late Triassic with the opening of the present Atlantic Ocean, which is still widening today at a speed of about 4 cm to 5 cm per year, the growth rate of a fingernail. As the plates split apart, volcanic rocks called basalts filled the fractures caused by rifting. Such rocks can be seen in several New Brunswick locales, including Grand Manan Island where they contain rare minerals called zeolites that attract collectors from across the continent. These Jurassic basalts, along with some Triassic sandstones found along the Bay of Fundy coastline, constitute the youngest rocks in the province.

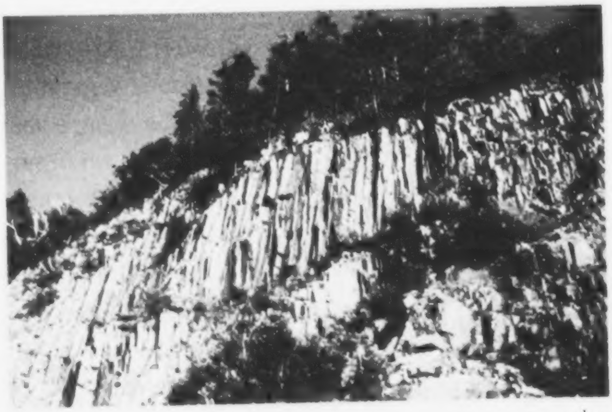


A Devonian fossil fish, *Yvonaspis campbelltonensis*. The photograph shows top view of the head shield and one visible eye. *Photograph courtesy of The New Brunswick Museum.*

Recent Geological Events

The beginning of the Tertiary around 65 million years ago marks the start of what is known as the Cenozoic Era in geological time. The end of the Tertiary coincides with what many scientists believe was a collision between the earth and an asteroid, a catastrophe that led, among other things, to the extinction of dinosaurs. New Brunswick rocks during this period became increasingly weathered and eroded down to a fairly level landscape surface that bore little resemblance to the contrasting highlands and lowlands of today.

The terrain appears to have remained gently undulating until the late Tertiary, when the entire area experienced another episode of broad regional uplift and tilting. This initiated a new cycle of erosion, during which the unsolidified sedimentary material and less resistant (mainly younger) rocks were worn down into valleys and lowlands. The deep stream dissection and incision of such waterways as the Upsalquitch River and much of the Saint John River apparently took



Columnar basalts are exposed at Grand Manan Island.

place around this time. The more resistant, older granitic and volcanic rocks gradually emerged from their weaker cover rocks to become highlands and uplands.

The Pleistocene ice ages constitute the most recent major episode in the geological history of the Maritimes. They laid a heavy hand on New Brunswick, as the province became inundated by glaciers that in places reached more than 2 km thick. Advancing ice sheets scraped up surface soil and plucked gravel and boulders from the surface and dropped them again, sometimes several kilometres away. Pebbles embedded in the base of the ice scoured and gouged the bedrock, leaving features such as glacial striations. When the glaciers paused or retreated, they laid down thick deposits of silt, sand, and gravel that disrupted drainage patterns, blocked streams and lakes, led to the formation of ponds and bogs, and gentled bedrock contours.

The glaciation events that essentially defined the surface of modern-day New Brunswick commenced about 100,000 years ago, waxed and waned, then ended about 11,000 years ago. Sometime in those distant icy millennia, the first human inhabitants arrived in North America. Scientists are still debating where they came from, when they arrived, and how they got here. The prevailing wisdom is that they crossed between Siberia and Alaska at least 12,000 years ago, or perhaps much earlier, across Beringia, a vast plain that once connected the two landmasses when sea levels were lower.

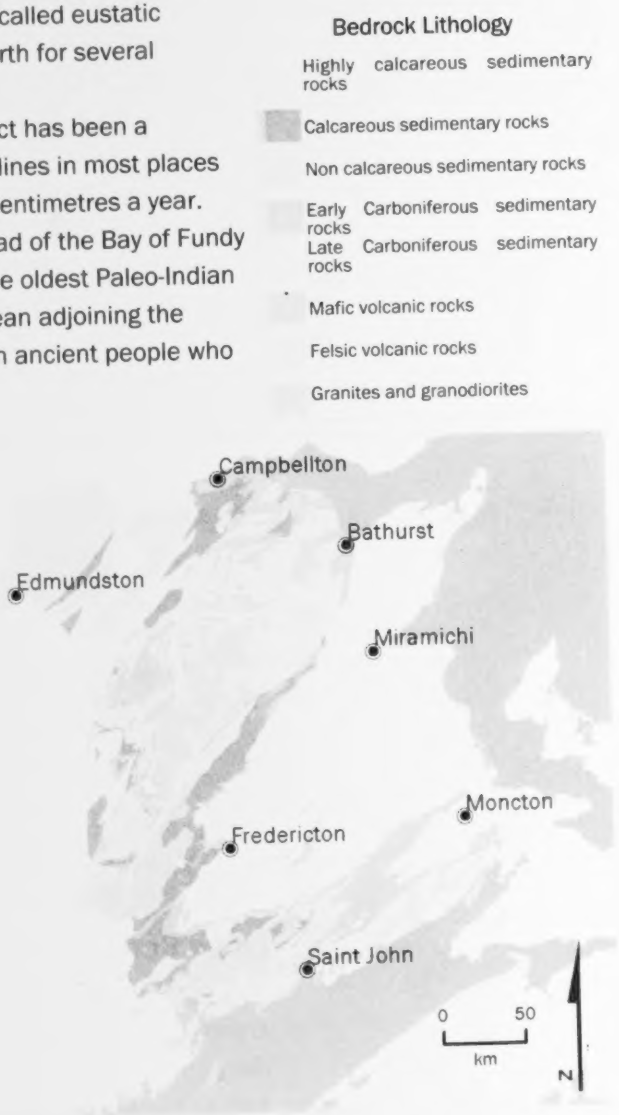
The study of existing glaciers helps geologists understand what might have happened in the past. Mount Edith Cavell Glacier, Jasper National Park, Alberta.

We do know that, as the glaciers eroded and disappeared around 11,000 years ago, the first post-glacial boreal forest gradually expanded over the land, and the earliest Paleo-Indians ventured into the Maritime region. Their arrival on the heels of the retreating ice signifies the tantalizing but hazy origins of the Early Period in Maritime human history.

A Coastline in Flux

One of the more intriguing aspects of the Pleistocene glaciations has been their effect upon sea levels. The colossal weight of ice warped and depressed the earth's crust by perhaps 100 m in places. At the same time, the ice sheets tied up massive volumes of water, causing the sea level to fall by more than 100 m below present levels. When the glacial ice began to melt, sea levels rose and partially flooded the land, then retreated again as land gradually lifted up from the loss of the ice's weight. The dynamic interplay between glacial rebound (also called isostatic rebound) and increased meltwaters entering the ocean (called eustatic change) caused shorelines to shift back and forth for several millennia.

Since about 3,000 years ago, the net effect has been a creeping rise in sea levels, such that our coastlines in most places are gradually submerging at a rate of several centimetres a year. The drowned forests in salt marshes at the head of the Bay of Fundy testify to a time of lower sea levels. Many of the oldest Paleo-Indian sites, too, are believed to rest beneath the ocean adjoining the present shoreline, hiding unknown relicts of an ancient people who once dwelled close by the sea.


Bedrock Lithology
Highly calcareous sedimentary rocks
Calcareous sedimentary rocks
Non calcareous sedimentary rocks
Early Carboniferous sedimentary rocks
Late Carboniferous sedimentary rocks
Mafic volcanic rocks
Felsic volcanic rocks
Granites and granodiorites
Campbellton
Bathurst
Edmundston
Miramichi
Moncton
Fredericton
Saint John
0
50
km
N

The Geological Picture Today

The foregoing events have combined to create the geological patchwork quilt of New Brunswick. It is a mosaic composed of tectonic units, microcontinents, and rock terranes all stitched together along faults and other geological features, and then modified by recent tectonic and erosional forces to create the landscape we see today.

The results of past geological events and processes are summarized by the bedrock geology map of New Brunswick. It depicts

New Brunswick
Lowlands
St. Croix
Highlands
N

Geomorphological Regions of New Brunswick, after Bostock (1970)

an extensive wedge of low-lying Carboniferous sedimentary rocks bordered on one side by the Northumberland Strait, and on the two remaining sides by areas of higher elevation composed of mainly older igneous, sedimentary, and metamorphic rocks. When bedrock geology is considered together with elevation and relief (topography), New Brunswick falls naturally into six geomorphologic regions. Each region delineates an area that differs from adjoining regions on the basis of bedrock type, relief, and elevation. This is the simplest depiction of the variety of landscapes in the province.

The significance of geomorphology to ecological land classification becomes apparent when we correlate geology and elevation with climate. As described in detail in the next section, New Brunswick's abrupt changes in elevation are partly responsible for its variable climate and, hence, for the diversity in natural vegetation that characterizes the landscape.

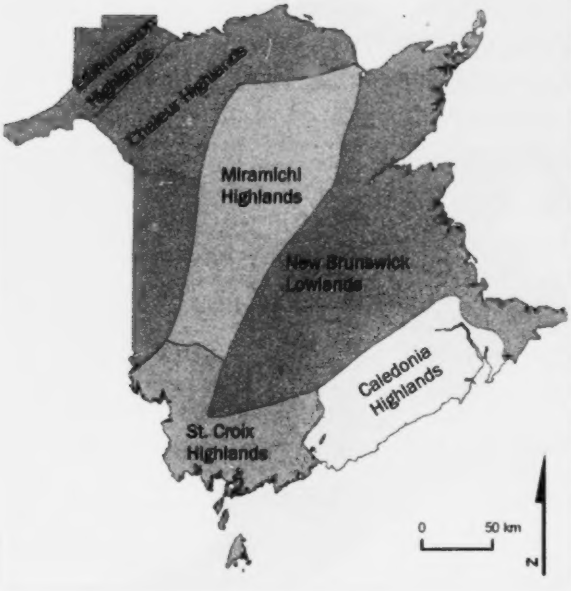
What Affects Our Climate?

Most of New Brunswick possesses a singularly unmaritime climate, despite its geographic placement in Maritime Canada. No part of the province lies more than 200 km from the ocean, yet its climate is distinctly continental, with hot summers and cold winters.

The climate of the province reflects an amalgam of three basic factors: latitude, proximity to large bodies of water, and elevation. The most significant of these is latitude, which determines the amount of radiation received from the sun. New Brunswick lies at approximately the same global latitude as Bordeaux, France, and Venice, Italy; however, their climates are quite unlike our own, being much warmer. Obviously, other climatic factors must come into play. We will examine these factors in the sections below.

Large Bodies of Water

The Bay of Fundy, Chaleur Bay and the Northumberland Strait embrace the south, north and east coastlines of New Brunswick, respectively. Yet, despite sharing a common association with the Atlantic Ocean, these large expanses of water exert substantially



Geomorphological Regions of New Brunswick, after Bostock (1970).

an extensive wedge of low-lying Carboniferous sedimentary rocks bordered on one side by the Northumberland Strait, and on the two remaining sides by areas of higher elevation composed of mainly older igneous, sedimentary, and metamorphic rocks. When bedrock geology is considered together with elevation and relief (topography), New Brunswick falls naturally into six geomorphologic regions. Each region delineates an area that differs from adjoining regions on the basis of bedrock type, relief, and elevation. This is the simplest depiction of the variety of landscapes in the province.

The significance of geomorphology to ecological land classification becomes apparent when we correlate geology and elevation with climate. As described in detail in the next section, New Brunswick's abrupt changes in elevation are partly responsible for its variable climate and, hence, for the diversity in natural vegetation that characterizes the landscape.

What Affects Our Climate?

Most of New Brunswick possesses a singularly unmaritime climate, despite its geographic placement in Maritime Canada. No part of the province lies more than 200 km from the ocean, yet its climate is distinctly continental, with hot summers and cold winters.

The climate of the province reflects an amalgam of three basic factors: latitude, proximity to large bodies of water, and elevation. The most significant of these is latitude, which determines the amount of radiation received from the sun. New Brunswick lies at approximately the same global latitude as Bordeaux, France, and Venice, Italy; however, their climates are quite unlike our own, being much warmer. Obviously, other climatic factors must come into play. We will examine these factors in the sections below.

Large Bodies of Water

The Bay of Fundy, Chaleur Bay and the Northumberland Strait embrace the south, north and east coastlines of New Brunswick, respectively. Yet, despite sharing a common association with the Atlantic Ocean, these large expanses of water exert substantially different effects upon the landscape.

Bodies of water that remain unmixed tend to become stratified, with the warmest layer on top in summer and the coldest layer on top in winter. The Bay of Fundy, however, undergoes daily mixing when incoming ocean tides from the southwest strike underwater reefs at the mouth of the bay and bring its bottom waters to the surface. The bay thus remains cold in summer and unfrozen in winter. This has a strongly moderating effect upon the climate of adjacent land areas and supports a distinctive red spruce-dominated forest, as well as wetlands that are home to a number of regionally rare plant species.

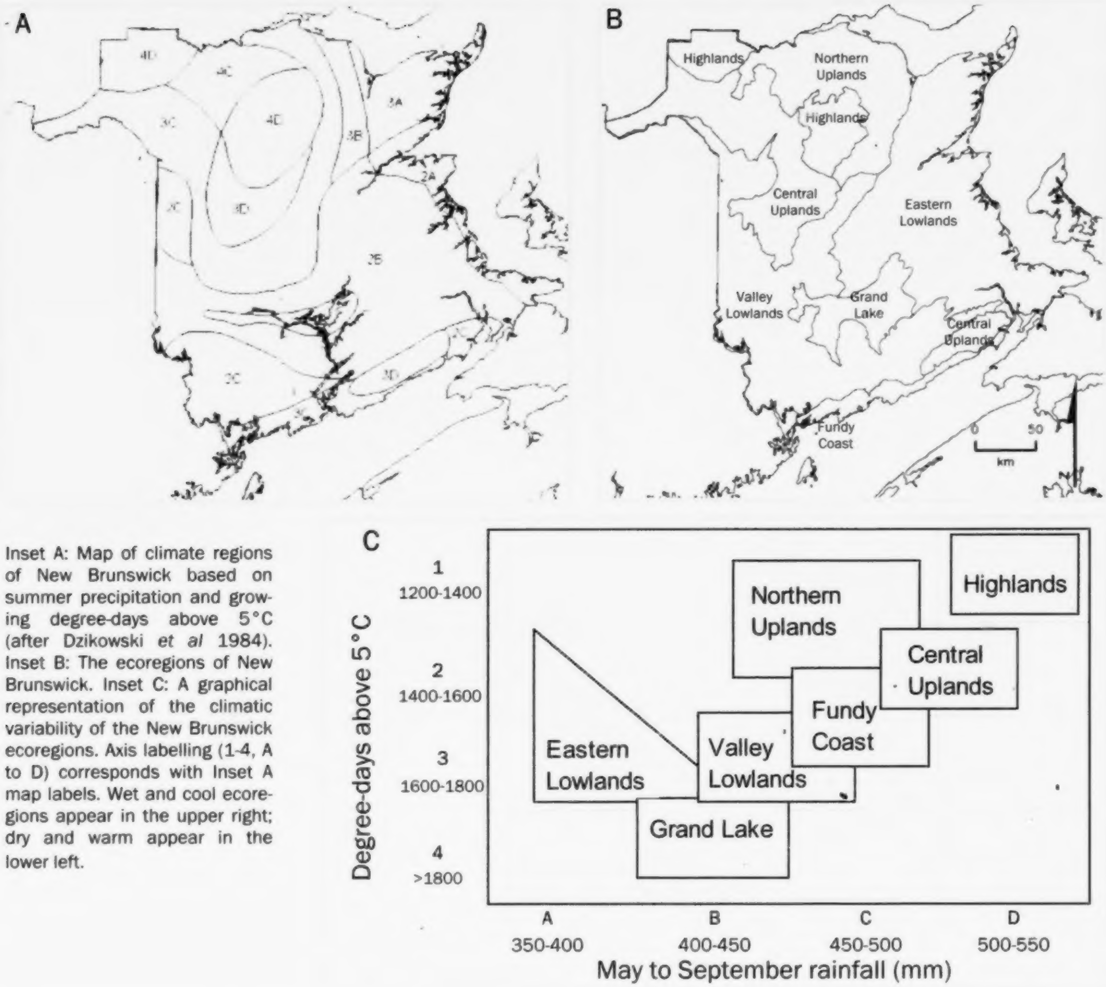
Tidal mixing also causes fog development along the Bay of Fundy, especially in spring and summer when the cold waters contact the warm, humid air from the interior regions. The fog increases moisture levels and decreases summer temperatures by masking the sun. Springs and summers along the Fundy coast, therefore, see cool temperatures that are more typical of those felt in the northern highlands. By way of compensation, the warmer winter ocean gives the south shore a frost-free period that is equal to, or longer than, anywhere else in the province.

The shallower waters of the Northumberland Strait and Chaleur Bay, on the other hand, are often frozen by mid-January, then grow as balmy in August as the sea off Virginia. They tend to warm the adjacent land areas during winter, but their moderating effect is less noticeable in summer, partly because prevailing winds are offshore. Indeed, the Northumberland coast experiences some of the highest summer temperatures and lowest summer precipitation amounts in the province.

Another summer hot spot is the Grand Lake area, which is protected from the prevailing westerlies by higher ground to the west. This large inland lake covers about 16.5 sq km and effectively acts as a lacustrine heat sink. By storing heat over the summer and releasing it over the fall and early winter, the lake bequeaths to the surrounding land an extended frost-free period. As a consequence, the area hosts a number of plant species with southern affinities.

Elevation

Elevation, together with the maritime effects of the Bay of Fundy, is a major influence on New Brunswick's regional climatic variation. Elevations shift from sea level at the coast up to more than 800 m in the northwest and central regions. The accompanying


A
B
Highlands
Northern Uplands
Highlands
Central Uplands
Eastern Lowlands
Valley Lowlands
Grand Lake
Central Uplands
Fundy Coast
0
50
km
C
1
1200-1400
2
1400-1600
3
1600-1800
4
>1800
Degree-days above 5 °C
Northern Uplands
Highlands
Central Uplands
Fundy Coast
Eastern Lowlands
Valley Lowlands
Grand Lake
A
350-400
B
400-450
C
450-500
D
500-550
May to September rainfall (mm)

Inset A: Map of climate regions of New Brunswick based on summer precipitation and growing degree-days above 5°C (after Dzikowski *et al* 1984). Inset B: The ecoregions of New Brunswick. Inset C: A graphical representation of the climatic variability of the New Brunswick ecoregions. Axis labelling (1-4, A to D) corresponds with Inset A map labels. Wet and cool ecoregions appear in the upper right; dry and warm appear in the lower left.

temperature drop with elevation rise produces variations in temperature and precipitation.

Where elevation is more uniform from north to south, as along the Northumberland Coast, the climate remains relatively consistent. Yet, where it increases substantially such as rising from sea level at Kouchibouguac National Park up to 820 m at Mount Carleton, climatic differences are dramatic. Because air temperatures normally decrease at a rate of 0.4° C for every 100-m gain in elevation, an increase in elevation is comparable, temperature-wise, to an increase in latitude.

When moist air of the prevailing westerlies meets elevated land, it cools as it flows upwards, causing its water to condense and fall as rain or snow. This is nowhere more apparent in New Brunswick than in the northwest and north-central highlands. There, the western slopes receive extremely high precipitation amounts, leaving rain shadows on the adjoining eastern flanks.

Lower lying areas, such as the Northumberland coast, gain less precipitation than the higher, inland locations. Air masses arriving at the coast from the uplands already will have dropped some moisture, but also are able to retain more water because they are descending and have become warmer.

Climate, Macro to Micro

Comparing New Brunswick's climate regions (inset A) with the ecoregion map (inset B) reveals similar geographic patterns at a very broad scale. At finer scales, the climate affecting a particular site is a function of three climatic levels acting simultaneously. Macroclimate, as we have just seen, is the relatively uniform climate of a region –– the climate zone. Topoclimate refers to the typical weather conditions of smaller areas, such as valleys and ridge tops, which reflect such factors as aspect, slope steepness, slope position as it affects the amount of incident radiation, and cold air drainage. Microclimate describes the actual local conditions in which an organism lives.

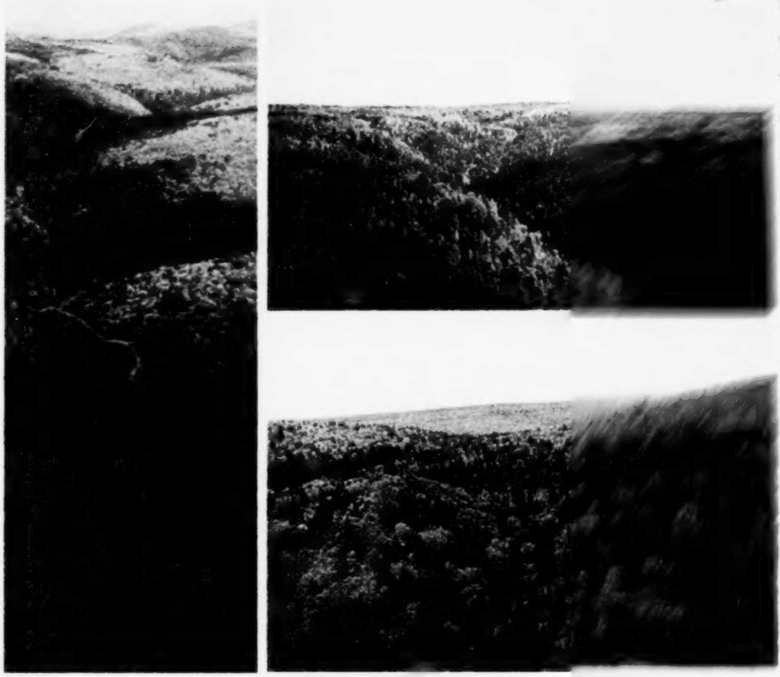
Ecological land classification considers different climate-controlling attributes, depending on the scale of observation. Macroclimate is a major criterion for delineating ecoregion boundaries and is also a factor in ecodistrict analyses. Topoclimate will be revisited later, in Chapter 5.

Soils

Soil is regarded as one of the three enduring features, but, in fact, embodies the interface between the organic and non-organic worlds. It straddles and links the living world of micro-organisms, bacteria, fungi and plants, and the non-living world of humus, mineral grains, bedrock, atmosphere, and precipitation. Soil also represents the dynamic interplay between climate and geology, as it manifests the action of climate upon rock through the phenomena of erosion and weathering in soil formation. Soil is used in ecological land classification to delineate the boundaries of ecosections and ecosites, two levels in the NBELC structure.

Glacial Processes and Soil Deposits

The landscape of New Brunswick is covered with a relatively fresh mantle of soil material composed of rock and mineral fragments that have been influenced by the crushing, grinding, washing and sorting processes associated with advancing and retreating glaciers. The mantle is 'fresh' in the sense that the glacial activity which ended 11,000 years ago exposed much unweathered rock and minerals to weathering and soil formation, whereas areas outside the farthest southern extent of the Laurentide ice sheet (Connecticut and points south) are covered by relatively old soils that have been in place for a much longer period of time.


Landscapes dominated by basal till deposits. Because basal tills were spread uniformly by advancing ice sheets, the surface shape of the land reflects the shape of the underlying rock..

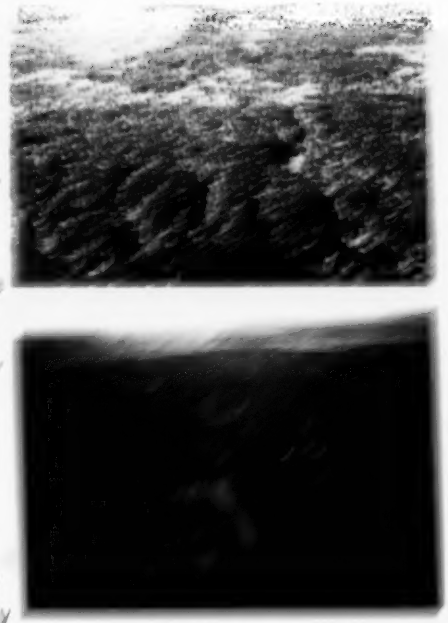
Basal Till Deposits

We must now imagine an advancing glacier as it gathers together soil, gravel, and boulders into its mass. It then grinds it into paste, and smears this crushed rock and mud mixture over bedrock beneath the glacier, not unlike peanut butter spread over a cracker with a knife. Soil deposited in this type of environment is known as basal till; it is relatively fine textured and compact below the rooting zone, a legacy of the huge weight of the ice bearing down on the material at its base. Basal till tends to conform to the shape of the underlying bedrock. It may be between 0.5 m to 20 m or more in depth, but is, on average, about two metres thick in New Brunswick. This is the predominant type of glacial deposit covering the hilly uplands of the province. Compared with other types of glacial deposits, basal tills have good nutrient-holding capacity related to their higher silt and clay content. Soils that are high in silt and clay and low in sand and gravel have a greater total surface area per volume of soil to which nutrient molecules may adhere. As we will see in Chapter 5, soil nutrient content has important implications for vegetation.

Ablation Till Deposits

Ablation tills are formed as glaciers melt and retreat. As the late

Pleistocene sun beat down on the tops of the glaciers, it exposed some of the rocks and rubble tied up in the glacier's mass. Exposed rocks absorbed heat from the sun and accelerated the process of melting around them, making holes in the glacier into which more and more gravel, sand, and mud would fall. With continued melting, the holes in the ice containing this debris would become inverted, the debris coming to rest as mounds on the earth's surface once the melting was completed. Today, well developed or typical ablation deposits appear to be dumped mounds of boulders, stones, cobbles, gravel, and coarse soil, the tops of which are separated by distances of perhaps 100 to 200 metres. The intervening hollows between the mounds are typically poorly drained forest or wetland. In some circumstances, drainage of the land is impeded to the extent that lakes or ponds form behind ablation deposits. Due to washing of the material as a glacier melts, ablation till lacks the silt and clay content of a basal till, is coarser textured, and tends to support plant communities tolerant of nutrient-poor, acidic soil conditions.



Examples of ablation till deposits. The surface shape of ablation tills reflects the shape and thickness of the glacial deposits themselves, and not that of the bedrock.

Glaciofluvial Deposits

Glaciofluvial deposits are typically well sorted deposits of silt, sand, and gravel. These deposits formed in the rush of water while the great continental glaciers were melting. They are the ancient fans, beaches, and gravel bars that formed in proximity to immense rivers that drained meltwater from the retreating ice sheets. A unique form of glaciofluvial deposit is an esker, which is typically deposited in a meltwater tunnel inside a melting glacier. Eskers are long, snake-like ridges of sand and gravel.

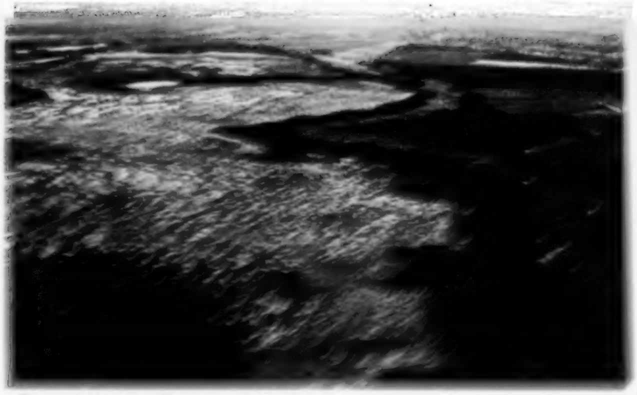
An esker at Little Tomoowa Protected Natural Area.

Organic Deposits

Organic, or peat, soils have formed since the retreat of the glaciers in cool, poorly drained, acidic environments where the growth and accumulation of (typically) sphagnum moss exceeds its rate of decay. The thickest peat deposit on record in New Brunswick was recorded at Gallagher Ridge and measured 9.9 m thick. The average depth of the larger peatlands is between 2 m and 3 m.

Recent Soil Deposits

Other soils have formed in relatively recent, post-glacial time. These include the intervale soils found along the major river valleys and the tidal soils that underlie the brackish estuaries where rivers meet the sea. Both soil types are formed when silt-laden water settles over the land during high-water times that coincide with the seasons or the tides. The soils are favoured for agriculture because they are virtually stone-free, moist, and enriched by seasonal floodwaters carrying silt, clay, and other organic materials.



The Juniper Barren has a remarkable variety of [illegible]

Top: Riverlain recent soil deposits near Jemseg. Below: Mudflats are recent soils deposited in a marine environment.

Soil and Nutrients

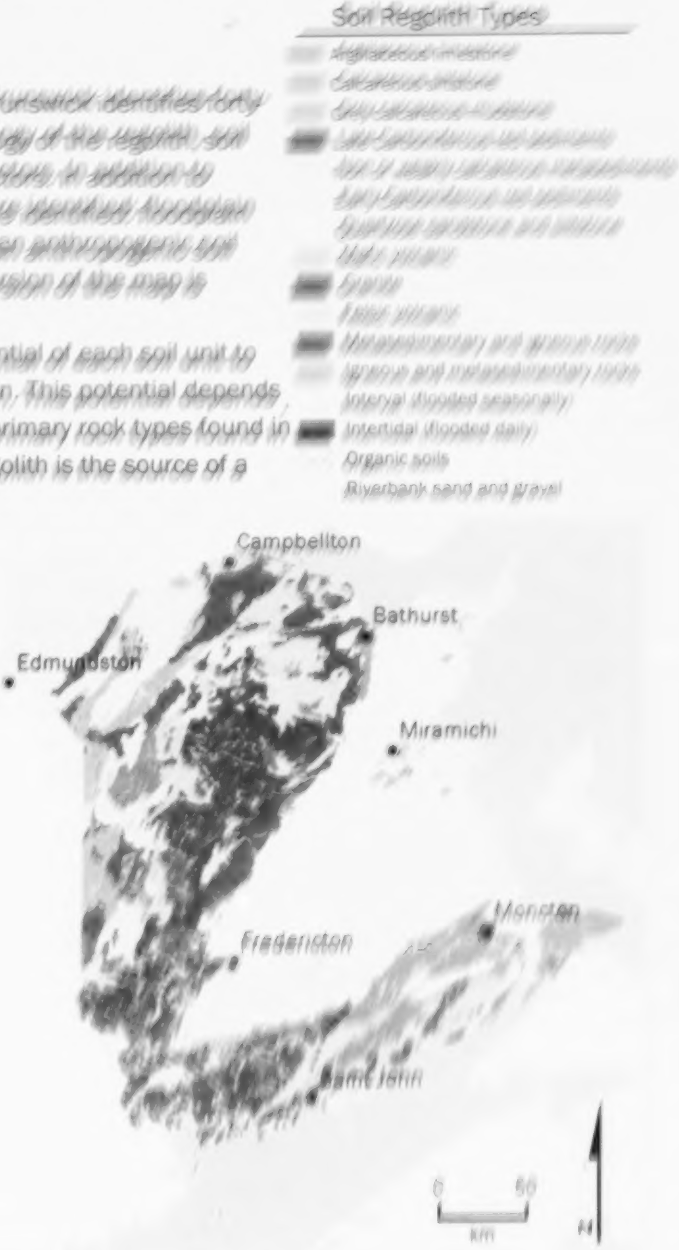
Nutrients are the chemical elements or simple mineral and organic compounds used by plants and animals to obtain energy or develop cellular matter. A forest ecosystem receives its nutrients from three basic sources. Some are derived from the breakdown of forest litter, such as fallen leaves, branches, and animal wastes, while others, such as nitrogen and sulphur, can be drawn from the atmosphere and incorporated into plant material by specialized organisms. The ecosystem's primary nutrient source, however, is the soil parent material, called regolith. Regolith is the layer of unconsolidated silt, sand, gravel, and rock fragments that overlies bedrock, but lies beneath the live soil layers containing roots and soil organisms. An important attribute of regolith is the lithology, or geological rock type, of its constituent rocks and pebbles.

The regolith is the main source of calcium, magnesium, phosphorus and potassium, which, along with nitrogen and sulphur, are known as the macroelements because they are used by plants in relatively large quantities. The regolith is also the source of a number of microelements, or trace minerals, which, although used in much smaller quantities, are still required for plant growth. These include iron, manganese, copper, zinc, boron, molybdenum, chlorine, and cobalt.

In order to gain a more detailed understanding of the relationship between soil, regolith, vegetation and forest growth, scientists have compiled nearly half a century's worth of soil data into a detailed forest soil map.

The Forest Soil Map

A map called the Forest Soils of New Brunswick identifies forty six different forest soil units based on lithology of the regolith, soil texture, method of deposition, and other factors. In addition to glacial tills, three other soil genesis types are identified: floodplain soils (interval and tidal), organic soils, and an anthropogenic soil composed of mining debris. A simplified version of the map is presented on this page.


Soil Regolith Types
Argillaceous limestone
Calcareous siltstone
Grey calcareous mudstone
Late Carboniferous red sediments
Red or weakly calcareous metasediments
Early Carboniferous red sediments
Quartzose sandstone and siltstone
Mafic volcanic
Granite
Felsic volcanic
Metasedimentary and igneous rocks
Igneous and metasedimentary rocks
Interval (flooded seasonally)
Intertidal (flooded daily)
Organic soils
Riverbank sand and gravel
Campbellton
Bathurst
Edmundston
Miramichi
Moncton
Fredericton
Saint John
0
50
km
N

The map allows us to predict the potential of each soil unit to supply elements important in plant nutrition. This potential depends mainly on the mineral composition of the primary rock types found in the soil. First, as mentioned above, the regolith is the source of a number of plant nutrients, with different rock types containing different amounts of these elements. In addition, mineral composition, especially the richness of calcium, magnesium and potassium, plays a major role the soil's ability to buffer or neutralize acidity.

Soil acidity is influenced by acid precipitation, by the weathering of rock types, and by certain organic processes. Its influence on the availability of various nutrient elements to plants is complex. Most nutrients are most readily available in slightly acid to neutral conditions (pH range from about 6 to 7). At extremes of acidity and alkalinity, different ions increase in availability, even to levels of plant toxicity. However the occurrence of such extreme conditions are rare in New Brunswick, particularly in the high pH range

While some important elements, such as nitrogen, are not a component of the regolith, the regolith is very influential on the acidity of the soil chemical soup, which is in turn influential on the biological processes that incorporate nitrogen into soil. For example, nitrogen-fixing bacteria are more active in soil of low acidity. Thus, nitrogen incorporation is indirectly related to regolith type.

A second biochemical means by which regolith affects soil fertility is through the effect of soil acidity on the breakdown of soil organic matter. Dead organic matter in the ecosystem is an important source of recycled nutrients. In order for the nutrients held within dead tree stems, sticks, leaves, insects, roots, skeletal remains and other detritus to become available to plants, there must be breakdown of those materials into simple molecular components. Soil dwelling insects, earthworms, nematodes, and numerous micro-organisms, such as bacteria and fungi, perform this essential service. In extremely acidic environments, such as the surface layers of a peat bog, very little or no decomposition occurs. On the most productive forest sites for tree growth, detritus on the forest floor is rapidly broken down and drawn into roots and into living biomass. The depth of litter on the forest floor is a good predictor of overall soil fertility and forest productivity.

Lithology and Fertility

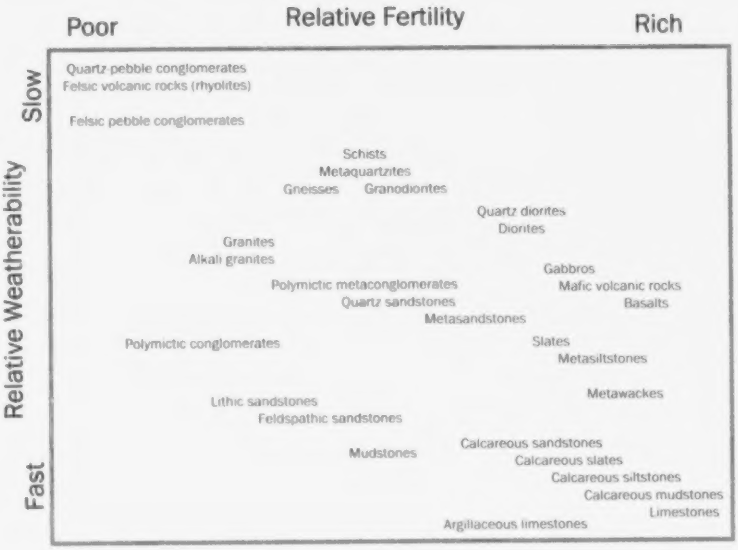
Rock types containing minerals with elevated concentrations of calcium, magnesium, and potassium generally weather into less acidic soil types than do rocks containing minerals low in these elements. In New Brunswick, the best lithological sources of calcium, magnesium, and potassium include limestone, calcareous sedimentary rocks, feldspathic sedimentary rocks, and mafic igneous rocks. Limestone and calcareous sedimentary rocks contain relatively high concentrations of calcium and/or magnesium carbonate. Feldspathic sedimentary rocks contain some calcium, potassium or sodium, and can yield moderately fertile soils, whereas siliceous or quartzose sedimentary rocks are high in quartz, but low in nutrient elements.

Felsic igneous rocks, such as granites and rhyolites, have a high quartz content, but a relatively low percentage of minerals containing the nutrient elements. They often weather very slowly. Mafic igneous rocks, however, contain minerals that are rich in iron, calcium, and magnesium, and consequently can yield moderately fertile soils.

Weatherability

Relative weatherability is an important factor in assessing the potential fertility of a forest soil unit. Rocks that weather or break down readily yield more nutrients than do rocks that resist weathering.

Among the sedimentary rocks, calcareous sedimentary rocks and limestone weather the most rapidly of all rock types under moist conditions, as they react chemically with the carbonic acid often found in precipitation and groundwater.



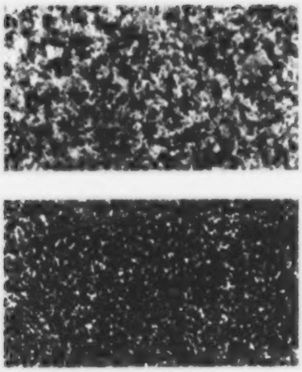
Rock types shown here are plotted according to their relative fertility and weatherability. Rock types producing nutrient-poor soils appear in the upper left, and rock types associated with rich soils are in the lower right.

Next in weatherability are the non-calcareous sedimentary rocks with a significant clay component, such as greywackes, mudstones, and siltstones. Clay particles resemble tiny, loosely connected mineral wafers and have an extremely high surface area relative to their volume (not unlike a stack of soda crackers). Water and acids are able to penetrate deeply into the interior of the grains to pry loose essential nutrients. The exposure of such a large surface area to the weathering agents of water, wind, sun and ice can result in rapid weathering.

Sandstones are less easily weathered, because sand grains display low surface area relative to volume (a sand grain as a solid glass ball comes to mind). Water and acids may pluck nutrients only from the outer surface of the grain. Feldspar grains, also a constituent of many types of sandstone, are more susceptible than quartz grains to chemical weathering; *feldspathic* sandstones therefore disintegrate more quickly than *quartzose* sandstones.

Mineral grains in sedimentary rocks essentially are 'glued' together by a cementing matrix. Igneous and metamorphic rocks, in contrast, are "fused" together in an interlocking pattern that makes them less easily weathered than sedimentary rocks.

Mafic igneous rocks generally contain minerals bearing calcium, iron, and magnesium. These minerals undergo chemical weathering more quickly than do the siliceous minerals in felsic igneous rocks. The weatherability of metamorphic rocks varies with their relative content of mafic and felsic minerals. The highly foliated, intensely compressed rock types, such as schist, tend to weather more slowly than do the less foliated types, such as slates.



Smoothed rock surfaces reveal the mineral composition of felsic (above) and mafic (below) igneous rocks. Note the contrasting light and dark coloration.

Soils and Ecological Land Classification

The approach to soil mapping used in producing the *Forest Soils of New Brunswick* is unique in that it focuses on features known to affect natural soil fertility, in addition to the other features noted above. This contrasts with more traditional approaches to soil mapping that focus less on lithology and inherent fertility. This aspect of soil mapping allows us to indirectly categorize the nature of the soil solution containing the nutrient elements that help to determine the rate of ecosystem processes, such as growth and decay. Scientists, managers and educators also have used the map to describe habitat and ecosystem types, to search for occurrences of rare flora and fauna, and to develop research, planning and conservation tools.

Conclusion

This chapter has described the geological pre-history of New Brunswick that explains both the unique physical layout of highlands, uplands, and lowlands, and the reasons why the province is so geologically diverse. It has also described the present day climate and related this to broad scale topography. The chapter concluded by describing forest soil and how its influence on plant growth is related to lithology and the mineral composition of rocks. The next chapter continues the story of ecological land classification by broadly describing the sweep of human history from glacial times to the present and speculating on how this has influenced the makeup and character of ecosystems.

New Brunswick is covered with ecosystems whose distribution and species makeup reflect natural and human influences.

Chapter 4

From Glacial Wilderness to a Home for Humanity

Since the retreat of the glaciers began about 11,000 years ago, a suite of historical factors has affected the distribution of species and ecosystems across the landscape, influences that linger to the present day. In this chapter, we give a few examples of how climate change, species migrations, and human activities have affected the distribution of species and ecosystems.

Climate Change Since Glacial Times

Natural trends in global temperature are related to 100,000-year-long cycles of change in the shape of the earth's orbit about the sun and the tilt of the planet's axis relative to the plane of its orbit. Described in the scientific literature as the Milankovitch theory, these cycles help to explain the occurrence of glacial and interglacial periods in North America. Since the glaciers melted 11,000 years ago, the global temperature has peaked (6,000 years ago) and started a decline toward the next glacial period. If climatic theories are correct, current global warming, though profound in its possible consequences for life as we know it, may be considered a 'blip' within a long-term trend of climatic cooling.

Between the early creation of tundra-like landscape in post-glacial New Brunswick and the subsequent development of forests on the landscape today, there has been a series of shifts in climate and associated vegetation.

Nature has left us a few clues – refuges of formerly abundant arctic-alpine plants here, and fossils there – that suggest the look of wild lands, even on today's most pristine natural landscapes, was very different in the past than it is now.

Remnants from a Warmer Time

As the glaciers began retreating from the land now known as the Maritimes, plants and animals gradually expanded their ranges beyond glacial refugia south of the ice sheet, colonizing the barren lands exposed at the edge of the receding ice. At first, the vegetation would have resembled the plant life presently found in the far north of Canada - shrubby and barren in places, with scattered clumps of trees such as tamarack, black and white spruce, and birch. Mastodons were among the now extinct mammals that were native to the Maritimes at the time.

In many parts of North America, fossil finds suggest there was a dramatic rise in global temperatures around 6,000 BP (years before present) that caused plant and animal species to migrate northward beyond their present-day northern limits. Buried layers of 6,000-year-old charcoal have been found in places too cold presently to support tree growth. In Labrador, for instance, huge spruce logs dating from this warm time have been found preserved in peat bogs that now occupy areas of stunted, cold-climate forest and treeless tundra.

The present range of Blue Cohosh in New Brunswick is probably smaller than in the past.

In New Brunswick, the evidence of this past warm interval is suggested by the patchy, discontinuous ranges of some plants and animals that are more typical of present-day warmer climates found farther south. A warmer climate facilitated the spread of these plants before their ranges were restricted as the climate cooled again after 6,000 BP. For example, the deciduous ironwood tree was probably more widespread in New Brunswick in the past than it is today; the small pockets of ironwood found at higher elevations in the province are likely the last remnants of a broader distribution. Similarly, an isolated remnant population of butternut occurs near Havelock, King's County, on limestone-derived soils. Although butternut occurs throughout much of the Grand Lake Lowlands Ecoregion, the Havelock population is outside the main contiguous range of butternut in New Brunswick. Studies of fossil pollen and twigs preserved in lake bottoms suggest that red oak and white pine were both more prominent and more widespread in New Brunswick 6,000 years ago than today. The maidenhair fern, Canada violet, blue cohosh and leatherwood are just a few of the plant species whose ranges have shrunk since early post-glacial time.

Maidenhair fern is believed to have been more abundant in New Brunswick in the past than it is today.

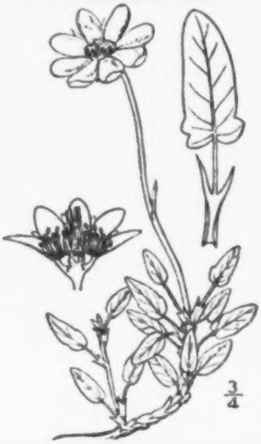
Ecologists have noticed that the broken, patchy distribution of these remnant populations coincides with places where soils are derived from limestone or calcareous rock. Geographic ranges of these populations may have shrunk in part because soils elsewhere became too acidic to support them, due to the natural soil leaching and acidification that occurs over thousands of years in areas where annual precipitation exceeds evapotranspiration. The bleached, whitish soil horizon situated immediately below the surface of the leaf litter in Maritime forests is evidence of this slow, long-term acidification process.

Meanwhile, cold- and acid-tolerating balsam fir, spruce species, jack pine, tamarack, and aspen were favoured by the cool climate regime developing after 6,000 BP.

Remnants from a Colder Time

Today, some colder-than-average habitats in New Brunswick still harbour plants and animals that were more abundant during the region's early post-glacial period. Many of these species occur along the coastal cliffs and on peat bogs of the Fundy Coast Ecoregion, where the cold waters of the Bay of Fundy have greatly affected the climate over many thousands of years. Curly-grass fern is among the plant species that have found a refuge near the Bay. A deep ravine in southeastern New Brunswick is home to many plants, now rare in the Maritimes, that once were among the most common plant species in the region. These plants include entire-leaved mountain avens, myrtle-leaved willow, small-flowered anemone, and soapberry. Another remnant cold-climate species, alpine bilberry, is

Entire-leaved mountain avens are found only in one location in New Brunswick, but are widespread in the Arctic. *Drawing from Britton and Brown (1913) and copied from USDA, NRCS (2006).*



now known only from mountaintops in north-central New Brunswick and from Miscou Island. Dwarf birch is similarly restricted in distribution here, but is abundant in high boreal forest areas near the treeline in Québec and Newfoundland.

Human Influences

It is difficult to separate the effects of humankind's activities from simply 'natural' influences on the distributions of plants and animals. The question arises: Are people part of Nature, or are they separate from it? Philosophers and ecologists have debated this issue at some length without a satisfactory resolution. At one end of this philosophical spectrum are those who believe that the earth belongs to humanity and that stewardship is mostly about satisfying human needs. At the other end are those who believe that humans are just one species of many who participate in a biotic community, all of whose members deserve respect and accommodation. In the sections that follow, we will limit ourselves to briefly demonstrating how humans have influenced the present distribution of several plants and ecosystem types in our region.

Dochet's Island in the St. Croix River, scene of Sieur de Monts' first encounters with Passamaquoddy people.

First Inhabitants

Over the last 300 years, the imprint left by humankind on the distribution of New Brunswick plants and animals has grown exponentially. For several thousand years prior to Sieur de Monts winter on St. Croix Island, Aboriginal peoples had been drawing sustenance from the plant and animal life of the coastlines and the uplands. Fire was used in various ways, including cooking and heating. Fires may have also been deliberately set to maintain "barren" areas free of trees, where blueberries and other wild fruit might thrive, or to create browse for caribou, moose, or deer. However, the first human inhabitants of the Maritime region do not appear to have relied on agriculture to the same extent as did other Aboriginal peoples who occupied the upper St. Lawrence Valley, and who used fire as a tool to clear land to make room for the cultivation of corn and other crops. Thus, it's possible that fires had a smaller effect on the look of the land in pre-contact time in the Maritimes, northern New England, and the Gaspé than it did in areas farther west and south where land clearing using fire was practiced.

The first humans to live in what is now New Brunswick probably facilitated the establishment of some medicinal and food plants by carrying them back from journeys to other parts of the continent. One unusual site in southern New Brunswick, for instance has wild leek as the dominant forest understorey plant over a fairly large area, which suggests cultivation or propagation in the past. Yet wild leek is normally rare in the province. Is it possible that bulbs of wild leek first arrived in the region in a leather pouch, having been carried a great distance on foot and by canoe? Bur oak is another species suspected of having been introduced to New Brunswick from points farther west. The map of its North American distribution shows it is widespread in the east and centre of the continent, yet it is an unusually patchy and discontinuous distribution that is shown. Did the aboriginal ancestors find that flour made from bur oak acorns was less bitter and therefore better flavoured than that made from local northern red oak?

Wild Leek. *Photograph courtesy of Stephen Clayden.*

Arrival of Europeans

With the coming of Europeans to North America, there arrived not only a new array of associated plants, animals, and microbes, carried both deliberately and inadvertently, but also a cultural outlook that contrasted with the indigenous culture.

Physical evidence suggests that the earliest European colonists allowed or encouraged substantial alteration of the physical environment. For example, Acadian colonists in the 17th and 18th centuries built earthen dikes to control tidal flooding of fertile salt marshes to make them available for agriculture. So extensive and complete was the diking and cultivation of salt marshes along the inner Bay of Fundy that few areas were left unaffected. The Acadians were followed by United Empire Loyalists and other British and European

Bur oak acorn and leaves. *Photograph courtesy of the online USDA Plants database (USDA, NRCS 2006).*

Acadian dike building, ca 1880. *Photograph courtesy of Université de Moncton library archives.*

colonists who cleared forests for settlement and agriculture. They also harvested large amounts of wood for buildings and fuel wood, for the domestic shipbuilding industry, and for large-scale export to Europe and to New England.

Agricultural practices of the early colonists introduced many exotic plants and animals, including plants that are present-day staple foods in North America. Europeans introduced a significant portion of the continent's present flora and fauna. Around 20% of known vascular plant species found in New Brunswick are originally from Eurasia. Most of these plants probably arrived as seed mixed with shipments of agricultural seed, or as seed attached to clothing,or in ship ballast.

Introduced plants include the common garden weed "plantain", which 17th-century aboriginal people in Massachusetts gave the name 'white man's footprint.' A number of animal species besides the familiar farm animals were also introduced, including the Norway rat, the European sparrow, rock doves, and starlings. The ravages inflicted on indigenous human populations by introduced pathogens, such as smallpox and tuberculosis, are well documented. In addition, pests and pathogens of native plants were introduced from other continents through North American ports. One example is a scale insect that was introduced through the port of Halifax, around 1890. This insect carries the *Nectria* fungus, the pathogen that causes the canker so prevalent here today on the bark of beech trees. Invasive organisms from other continents have continued to be introduced in recent times.

Plantain (top) and dandelion (bottom) are familiar garden weeds that were introduced by European colonists.

Colonists, Homesteading, and the Forest

Early colonists were aware of the relationship between landscape position, soil type, vegetation type and good farming prospects. Areas typically cleared for houses, farms, and fields later became larger settlements or towns that we now associate with the strong farming traditions of southeastern New Brunswick, the Saint John River valley and its tributaries, the Bay of Chaleur shoreline, and the lower Miramichi valley.

Since 1940, the percentage of land area devoted to agriculture in New Brunswick has for a variety of reasons declined significantly. Forests have become re-established on abandoned crop and pasture land. White spruce is often referred to as old-field spruce because of its association with abandoned farm fields. Poplar, white birch, grey birch, and alder are also commonly found in old-field stands. Their light seeds are widely scattered by wind, and their seedlings can compete successfully with the common grasses and herbaceous field and pasture species. Where a seed source exists close by, white pine may also become established on old fields.

On aerial photographs, it is common to see sugar maple-yellow birch-beech stand types separated by a straight-line boundary from dark-coloured, conifer-dominated stand types. These conifer-dominated stands mark the previously cultivated fields or pastures of old homesteads. Common speedwell and yarrow are two understorey plants introduced from Europe that commonly persist under forest cover on old fields; our native wild strawberry is another. In fact, the presence of these species can alert a naturalist that a forest stand probably has a history of ploughing or pasturing. A dark-coloured upper soil layer composed of mixed organic matter and mineral soil, with the presence of earthworms, can also indicate a history of ploughing or intensive upper layer soil disturbance by the hooves of farm animals.

Homesteading, New Denmark area. *Photograph courtesy of the Provincial Archives of New Brunswick.*

Remnant patches of historically-prevalent forest exist alongside current agricultural land and typical old-field stands. In the Saint John River valley, the abundance of formerly common tree species such as butternut, bur oak, black cherry, and basswood, has decreased since the period of homesteading colonists. More recently, inundation of islands, riverside forests, and wetlands by hydroelectric dam projects in the 20th century has had an unquantified negative impact on the extent of a species rich forest type called the Appalachian Hardwood Forest.

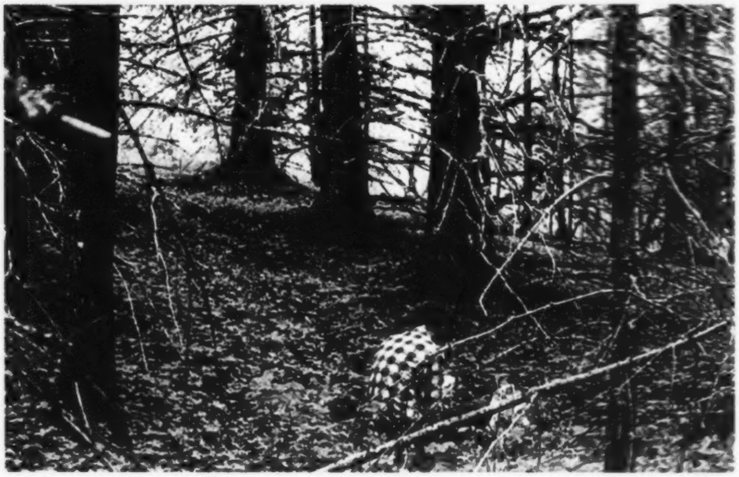
Old-field white spruce (dark patch in lower left) contrasts with the original vegetation on a tolerant hardwood ridge.

The original Land Grant Surveys dating from the 18th and 19th centuries, and now housed in the Provincial Archives of New Brunswick, have proved to be a valuable resource for reconstructing New Brunswick's precolonial forest. Colonial surveyors systematically recorded the tree species present at regular intervals along survey lines. These records provide a fascinating glimpse of past forest composition and allow us to measure the change.

Effects of Forest Harvesting

Logging, and land clearing to had significant effects on the composition and extent of New Brunswick's forests. In the 1700s and early 1800s, logging efforts were concentrated almost exclusively on New Brunswick's legendary white pine forest. By the latter part of the 19th century, spruce had supplanted pine as the most important species on the annual log drives on New Brunswick's major rivers. The harvests of spruce were highly selective, focusing on large trees that, for

Old-field white spruce stands often are very branchy and conceal the evidence of homesteading, such as rock piles and stone fences.



the most part, occurred in the well drained stands with good access to rivers and streams for log driving. These harvests focused in the three lowland ecoregions and did not penetrate to the uplands and highlands until later. Anecdotal evidence suggests that hemlock was also a prominent tree in much of the forest of New Brunswick in the middle of the 19th century, but its abundance was diminished greatly after hemlock bark became in high demand as a source of tannin for leather-making.

The Changing Character of the Forest

As markets grew through the 19th century and large-diameter trees became scarce, accessible stands were cut repeatedly for sawlogs, each time with a lower minimum log diameter limit. 'Leave anything smaller than 12 inches diameter at breast height (DBH)' was the common rule of thumb. After the pulp and paper industry became established in the early 20th century, woodlands already cut over for pine and spruce sawlogs were re-harvested to even smaller diameter limits. In the 1940s, clearcutting began to emerge as the predominant forest harvesting practice.

An ecological consequence of clearcutting was to create large open areas in the forest where the remaining vegetation, including understorey plants and tree seedlings, is subject to extremes of temperature and moisture. In clearcut areas where natural regeneration has developed, this has led to an increase in the percentage of balsam fir and a decline in the percentage of spruce in coniferous forested areas. This effect is more pronounced in the three lowland ecoregions and the Fundy Coast Ecoregions, where in pre-contact times fir is believed to have been a subdominant species, while red spruce was the predominant spruce species. The increase of fir at the expense of spruce is due to the genetic tendency of fir to grow longer roots in the seedling stage than spruce seedlings of similar size. Young fir seedlings can, therefore, gain access to sources of soil moisture unavailable to spruce seedlings and are consequently better able to withstand the tendency to dry out when the forest canopy is removed and the young trees are exposed to extreme wind and sun.

The balsam fir population also expanded after implementation of the insecticide spray program against the spruce budworm, balsam fir's major insect pest, from the late 1950s until the 1980s. Although the budworm attacks both fir and spruce, fir is less able to withstand sustained defoliation and, thus, succumbs more readily.

Species or Genus	Circa 1800	Circa 1993
Spruce	19.4	27.8
Maple	18.4	16.4
Birch	15.8	11.7
Cedar	7.2	3.5
Balsam fir	7.2	19.7
Beech	6.9	2.5
Ash	5.8	0.5
Hemlock	4.4	0.9
Aspen/ poplar	4.4	8.8
Tamarack	4.2	1.9
Pine	3.7	3.6
Other hardwoods	1.1	2.4
Oak	0.5	0.2
Alder	0.4	0.0
Ironwood/ hornbeam	0.3	0.2
Butternut	0.3	0.0
Total	100	100

The change in percent frequency of common tree species and species groups between 1800 and 1993 in Kings County, New Brunswick. The increase in spruce abundance probably reflects the combined effects of a decline of red spruce and an increase of white spruce on

Several scientists have speculated that the predominance of red spruce in forests of the three lowland ecoregions and the Fundy Coast Ecoregion in the 19th century and early 20th century reflected the role played by spruce budworm in limiting the balsam fir population. Fire suppression during the 20th century is a third factor that contributed to the expansion of balsam fir. Balsam fir is extremely vulnerable to fire, whereas morphological adaptations often allow spruce seed to withstand wildfire and to re-establish itself by scattering seed over burned areas.

Thus, over the past half century the high proportion of balsam fir in the forest has been an important determinant of natural forest dynamics and of forestry policy in New Brunswick. Because balsam fir lacks the longevity and budworm resistance of spruce, industrial forestry has been geared for many years to harvest stands first where tree mortality and its associated volume loss is imminent. This has also led to the widespread planting of spruce, with the intention of improving per-hectare timber yields and secondarily to begin to reverse the predominance of balsam fir in the forest.

Among the plant species considered vulnerable to drying out following clearcutting are the Calypso orchid (top), the showy ladies slipper (middle), and the clustered coral lichen (bottom).

Current Trends of Ecosystem Change — Detectable or Not?

Several of the narratives presented in this chapter were elaborated with the help of knowledge gained through ELC. Trends are easier to detect with the benfit of hindsight than they are to predict before many years have elapsed. Ecological responses to disturbances often are so complex and variable seasonally or from year to year that they are undetectable through observations made over only a few years or even a decade or two. Many of the effects listed in this chapter, such as those associated with the red spruce-balsam fir dynamic, were impossible to detect until sufficient time had passed and sufficient area had been affected that a trend became recognizable.

Questions about the effects on species and ecosystems of challenges posed by air pollution, water pollution, and climate change are some of concerns that preoccupy society today. For example, there is evidence that the effects of acid rain and ground-level ozone in the Bay of Fundy region causes damage to the outer waxy coating of leaves of birch trees, thus facilitating fungal infection, which causes leaves to brown and fall prematurely. In southwestern Nova Scotia, the acidity of lakes in spring sometimes reaches levels that can affect the reproduction of salmon and trout.

Can similar effects be expected in New Brunswick? Does mercury contamination of New Brunswick trout show regional variation related to ecosystem attributes? How will climate change affect New Brunswick ecosystems?

The NBELC can help address these questions to the extent that it helps scientists to recognize and identify the uniqueness of regional or local environmental circumstances. It is one tool in the toolkit of scientists who must also describe the problem, imagine or *model* how the problem comes about, test the model in the real world, and let others know about what they found.

Conclusion

In this chapter, we have examined past events and their role in determining species distribution in New Brunswick, with a specific focus on postglacial migrations, climate change, and the dimensions of human. Together, past events and their effects comprise one of the major influences on 'what lives where, and why'. Ecological gradients also play an important role in ordering many aspects of the natural world. In the next chapter we will leave the past behind to again focus on the specific ways that these attributes of the physical environment or ecological gradients today affect the makeup of biological communities and the distribution of species in modern-day New Brunswick.

A group of field biologists and naturalists shares ecological observations and findings while on a botanical field tour. Grande Plaine, Miscou Island.

Chapter 5

Ecological Gradients

The work of poets and painters is successful when they find simple yet eloquent ways to give meaning to complex ideas or objects. Ecologists are engaged in a similar creative process when they synthesize diverse knowledge about land and vegetation into a simple expression that captures something essential about the distribution of plants and animals. With their well-rehearsed stories about flora and fauna, our park naturalists and museum curators are essentially play the role of ecological storytellers. When ecologists talk or write about relationships between vegetation and ecological gradients, they are developing stories and analogies to capture their listeners' or readers' imaginations. An ecologist invokes a level of detail appropriate to the scale of the phenomenon being described, much as certain paintings can portray the essence of a spruce, pine, and birch forest, or a few written words can evoke the image of an entire landscape.

What are Ecological Gradients?

The distribution patterns of species and ecosystems are not only a function of post-glacial migrations and human influences, but also a present-day response to ecological gradients. Ecological gradients are measures of the physical environment that explain the distribution of organisms and ecosystems in terms of environmental tolerances. Commonly used ecological gradients include air temperature, precipitation, soil fertility, soil acidity, moisture regime, and frequency of natural disturbances such as fire, wind, or infestations. The major challenge for ecologists is to explain the distributions of organisms with simple models that describe vegetation change relative to a small number of important gradients.

The most obvious and well-documented ecological narratives of this type describe very broad, continental-scale factors. For example, a traveler driving south on I-95 toward Florida may notice the transition of vegetation cover from a predominantly mixed-hardwood-spruce-fir forest of Maine, to a hardwood forest of Maryland, to a southern pine and hardwood forest as one continues through the Carolinas. These changes of forest type is related to the climatic differences well known to most travelers seeking sun in wintertime. At a finer scale in New Brunswick, different cities and towns are known to be situated with respect to several environmental gradients of temperature and precipitation. We attempt in this chapter to add to and refine these narratives by focussing on increasingly fine-scale characteristics and their relationships to vegetation differences.

Why Study and Map Ecological Gradients?

In spite of the best efforts of biologists, foresters and naturalists, we really don't know where all the populations of various plants and animals are located. Gradient analysis helps us to understand the geographic distribution of species and ecosystems. Gradient analysis enables us to use the varied abiotic, or non-living, aspects of our surroundings that explains much about the geographic distribution of species and ecosystems. When applied to natural resource inventories of timberlands or wetlands, gradient analysis enables biologists to develop a broad focus on ecosystems and the species within them, and to better understand their critical ecological and economic benefits. Gradient analysis also helps us to avoid some of the limitations associated with managing for only one or a limited number of resources or values. Ecological land classification (ELC) is designed to capture intervals in these gradients.

Species and Traits

Many ecological gradients can be detected by observing vegetation differences that are visible at fairly broad geographic scales. Orbiting the earth, for example, an astronaut can detect different vegetation zones on the North American continent. However, those distribution patterns represent the sum of interactions that take place at the scale of the individual plant or animal. Interactions at the scale of the of a species that has certain traits, determines whether it will flourish or perish in a given environment.

It is easy to recognize differences between tree species on the basis of leaf shape, bark texture and colour, or the "shape" or profile of the tree. These morphological traits describe a plant's physical appearance. Physiological traits include photosynthesis, transpiration, and respiration rates. Phenological traits relate to the timing of various plant processes, such as leaf emergence in spring, leaf fall in autumn, the timing of flowering and seed dispersal. Seed number and size, germination requirements, and time to reproductive maturity are important traits describing the reproductive biology of a species. Morphological, physiological and phenological traits determine a plant's shade and moisture requirements for establishment and growth, its ability to tolerate or withstand various types of environmental stresses, and its ability to grow and compete with other species for resources, such as light, moisture, and nutrients.

Certain traits, or suites of traits, may be advantageous in some environments and disadvantageous in others. Some species have suites of traits that facilitate rapid growth and reproduction under conditions of ample light, moisture and nutrients, allowing successful competition against other plants. Other species, with different traits, are able to grow and reproduce under environmentally stressful circumstances, such as low moisture or poor nutrient conditions, dense shade, or high salinit. Some species are found over a wide range of environmental conditions; others are very specific in their requirements. However, there does not appear to be any universally adapted species that is able to thrive under all conditions. Thus, both within and among plant communities, one finds a variety of traits, resulting in a range of possible responses to environmental changes, both along environmental gradients and over time.

Major Gradients Affecting Forest Composition

In forests, three useful environmental gradients operating at fine geographic scales are topoclimate, soil nutrient regime, and soil moisture regime.

Topoclimate

Topoclimate is the climatic regime conferred on a site by its landform shape, its slope position, and aspect. One of the primary effects associated with topoclimate is cold air drainage.

Cold air drainage refers to the tendency of cold air to settle in lower landscape positions at night forming 'frost pockets' or 'frost hollows'. During cold nights in spring and fall, the valleys affected by cold air drainage are the first places to be touched by frost. In narrow, V-shaped valleys, the lower slope positions receive smaller amounts of solar radiation than do the hilltops and consequently are better places for northern coniferous species to grow.

In areas close to larger lakes, coasts, and the broader, U-shaped valleys more typical of the three lowland ecoregions, late spring and early fall frosts are less frequent than in the uplands and highlands where narrow valleys are more common. In these lowland areas, cold air drains at night from higher ground and becomes mixed with heat released by the relatively large volumes of water carried in lowland rivers, thus preventing frost. Over time since glaciation, this has led to greater predominance in the broad lowland valleys of tree species with southern continental distributions such as the maples and ashes.

The frost hollow effect is demonstrated here by pine, spruce, and fir lining lining the valleys, and sugar maple and birch on the hilltops along a tributary of the Upsalquitch River.

An interesting exception to this general pattern of tolerant hardwood trees on the summits with softwood trees in the narrow valleys occurs at Mount Sagamook in northern New Brunswick. On the north slope of the mountain (see photogrph on facing page), tolerant hardwood stands at the base of the mountain (the red and orange band) gradually give way to fir-spruce stands (first dark green band) followed farther upslope by mixed stands of black spruce and white birch (alternating yellow and dark green bands). The summit is capped with a subalpine ecosystem dominated by Laborador-tea, mountain cranberry, and stunted black spruce.

There are two main reasons for this anomalous pattern on Mount Sagamook. The first is the great size of the mountain in comparison with otherNew Brunswick landforms. Mount Sagamcok rises more than 500 m above Nictau Lake and, therefore, reflects regional climatic gradients associated with a decrease in temperature with elevation. The increase in elevation is, thus, equivalent to traveling farther north. A second factor that explains the vegetation pattern on Mount Sagamook is the soil fertility gradient from lakeshore to summit. Soils along the lakeshore are enriched with calcareous sedimentary rock fragments and contain relatively base-rich minerals that have higher nutrient content, while the summit is predominantly bare rhyolitic bedrock, littered with frost-shattered stones and boulders and covered, in some parts, with a thick organic mat of detritus and roots.

A northward view from near the summit of Mount Sagamook, Mount Carleton Provincial Park.

Aspect

Aspect is the orientation of a slope with regard to the four points of the compass and is another factor contributing to topoclimate. As a general rule, slopes with a southerly aspect in the northern hemisphere tend to receive more sun exposure than do north-facing slopes. Ecological differences due to aspect are difficult to correlate with plant and animal distributions in New Brunswick. A possible explanation for this lack of correlation may be the region's high frequency of cloud cover, which diffuses light and heat and mutes the effect of aspect as an environmental gradient, in comparison to parts of the continent that are more arid or are more strongly sloping. However, some associations with aspect do stand out, such as the tendency for eastern hemlock to be abundant in the lowland ecoregions on north-facing slopes in areas where it is otherwise relatively scarce.

Soil Nutrient Regime

The ecological gradient of nutrient availability is correlated with a gradient of decreasing acidity and increasing weatherability of the rocks and rock fragments that make up the bulk of mineral soil (see Chapter 3). Acidic igneous rocks occupy the poor end of this nutrient gradient and grade into richer, non-calcareous sedimentary rocks, mafic igneous rocks, calcareous rocks, and limestone. In forest soils, low soil acidity is often associated with higher nitrogen content and ratios of carbon to nitrogen that are correlated with high plant nutrient concentration. These factors enable high rates of activity by soil micro-organisms, leading to high rates of plant growth, decomposition, and nutrient cycling.

Plant species composition also reflects soil nutrient regime. On rich sites, for example, understorey plant species such as the small enchanter's-nightshade, naked mitrewort, bristly currant and alternate-leaf dogwood are more likely to be found. In the overstorey, sugar maple, yellow birch, white spruce and eastern white cedar also have greater representation. In warmer ecoregions, white ash, ironwood and butternut are often present on such rich sites. Rich soils harbour more rare plant species, and places where these soils are found are also favourite areas for naturalists to explore.

On poor soils, many plants share adaptations that help them to conserve nutrients. Among these strategies is a tendency to be evergreen. Sheep laurel, Labrador-tea, and wintergreen are among the understorey species typical of nutrient-poor sites. In these species, the small quantity leaf litter dropped in a given year is typically low in nutrient elements because the plants reabsorb a high percentage of nutrients into the living biomass as a nutrient conservation measure. In contrast, species adapted to rich sites tend to conserve nutrients less and drop larger quantities of litter. Sugar maple, yellow birch, and ash are among the species that tend to be more abundant on sites that represent the high end of the nutrient gradient.

There is an important nutrient gradient affecting wet sites that spans differences in oxygen concentration. Oxygenated water occurs where water is not stagnant, but seeps laterally through the soil profile. While oxygen-starved soils typically are associated with level or flat ground, soil water oxygenation may occur with as little as two degrees of slope. Under oxygenated conditions, micro-organisms are able to thrive and decomposition of dead organic matter proceeds. Other names applied to sites where oxygenated water appears at the surface include 'seep' or 'spring'. Where oxygen is lacking, conditions favour the accumulation of thick surface layers of organic matter due to the relative inactivity of soil organisms. In this way, oxygen status on wet sites is an important determinant of soil nutrient regime.

In all climate regions throughout New Brunswick, forests on wet, low-oxygen soils tend to have a boreal "look". The soil effects are so strong that they overwhelm climatic influences. Black spruce, tamarack and shrubs (including speckled alder, Labrador-tea and rhodora) usually dominate such sites, while sphagnum mosses dominate the understorey. These sites are also very acidic, and the species there tend to reinforce soil acidity because of the acidic nature of their leaf litter and other dead plant parts. The most extreme expression of the effect of low soil oxygen under wet conditions is the formation of peat bogs (discussed later in this chapter).

Soil Moisture Regime

Three factors are primary influences on soil moisture regime: bedrock permeability, landform position, and a suite of soil attributes including texture, stoniness, organic matter content, and the presence of a constricting or compact layer. These factors influence a site's water supply and also the drainage rate of water within the soil's upper layers where most tree roots are found.

Bedrock permeability

Bedrock permeability describes how moisture travels through bedrock. Many bedrock areas contain cracks and fissures that allow moisture to infiltrate through to groundwater. As well, some rock types are more porous than others. In New Brunswick, volcanic and granitic rocks tend to be impermeable, whereas metasedimentary rocks are typically quite permeable. Where bedrock is permeable, good drainage and moderate soil moisture conditions are predominant. Where bedrock is impermeable, the soil moisture regime is more variable due to pooling of water in bedrock

The Kennedy Lakes formed where glacial deposits block drainage pathways, and impermeable bedrock, in this case granite, prevents percolation of water to deeper levels.

depressions; here, the composition of vegetation can reflect restricted drainage. Lakes and ponds tend to be more numerous where rocks are impermeable, which is why a disproportionately large number of lakes and ponds in New Brunswick occur on granitic bedrock.

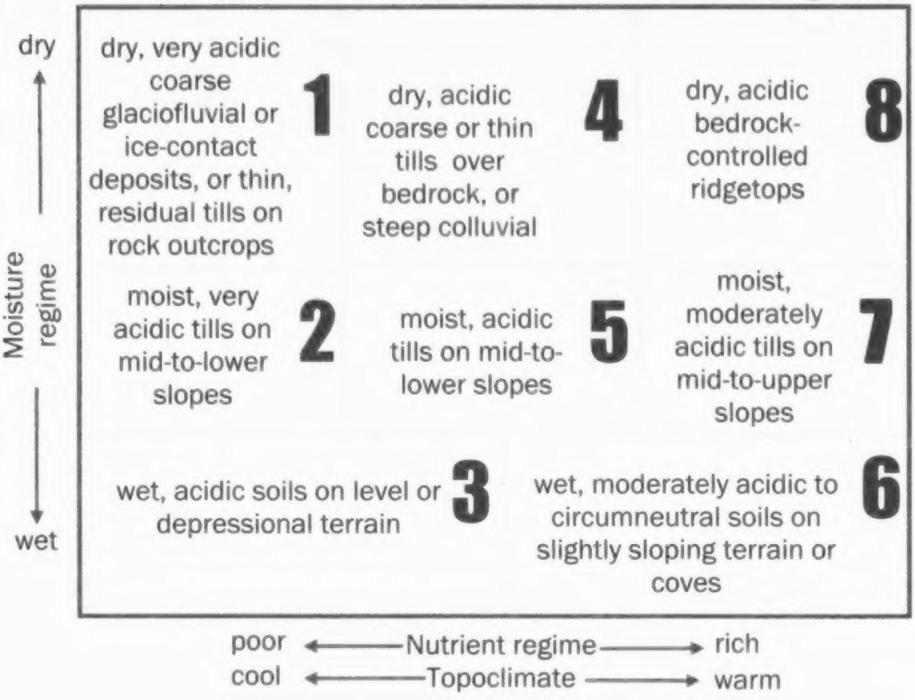
Landform position

Sites are either moisture-shedding and receive water input primarily from precipitation, or they are moisture-receiving and are recipients of laterally-flowing seepage water. Whether a sites sheds or receives moisture depends on where it is situated on the landform. Coves are broadly concave, sloping parts of a landform where seepage water collects due to landform shape. Other moisture-receiving sites include flat areas or depressions, where surface water collects or where groundwater comes close enough to the surface to influence vegetation. Moisture-shedding sites are the high points and ridges from which moisture drains away.

Soil attributes

The presence of impermeable or highly compact layers in the soil will tend to slow soil drainage and contribute to a wetter moisture regime. In eastern New Brunswick, soil attributes are the primary

Soils and topography



dry, very acidic coarse glaciofluvial or ice-contact deposits, or thin, residual tills on rock outcrops **1**	dry, acidic coarse or thin tills over bedrock, or steep colluvial **4**	dry, acidic bedrock-controlled ridgetops **8**
moist, very acidic tills on mid-to-lower slopes **2**	moist, acidic tills on mid-to-lower slopes **5**	moist, moderately acidic tills on mid-to-upper slopes **7**
wet, acidic soils on level or depressional terrain **3**		wet, moderately acidic to circumneutral soils on slightly sloping terrain or coves **6**

The edatopic grid for New Brunswick uplands. The grid to the right describes ecological site types, or *ecoelements*, in terms of their soils and topographic character. The grid on the facing page identifies associated typical forest vegetation .

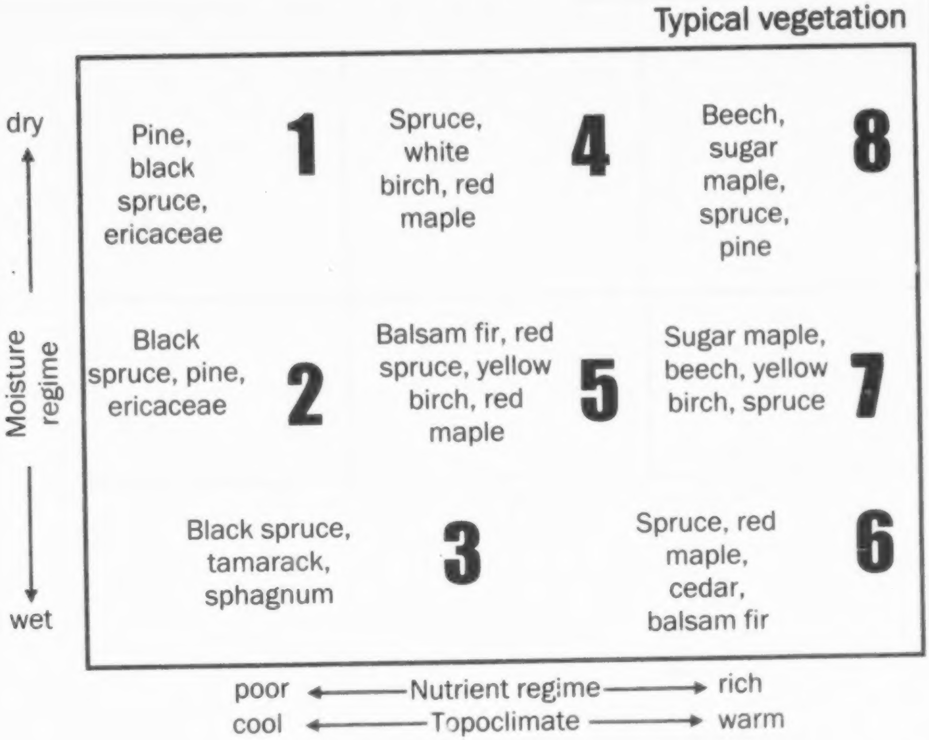
determinants of soil moisture regime. Over much of the area, a reddish, clay-rich soil horizon greatly slows infiltration of water to the bedrock. These soil conditions have contributed to the formation of large areas dominated by bog and swamp forest. In contrast, where soils are stony, gravelly, or sandy, and freely draining, lack of moisture can limit tree growth.

Dry or droughty conditions prevail where bedrock comes close to the soil surface in moisture-shedding situations. Alternatively, where sites shed moisture and the soil contains high volumes of rock or stones, the effective rooting space and moisture storage capacity of soil is restricted. Pine, blueberries and spruce are typical plant species on such sites.

Moving along the soil moisture gradient from moist to saturated or flooded conditions, one encounters forested wetlands, such as silver maple swamps, and treeless wetlands, such as marshes and peatlands.

The Edatopic Grid

After an ecologist has studied how topoclimatic, moisture, and nutritional gradients interact, it is a short step to categorizing this information in terms of fine scale ecological site-types, or ecoelements.



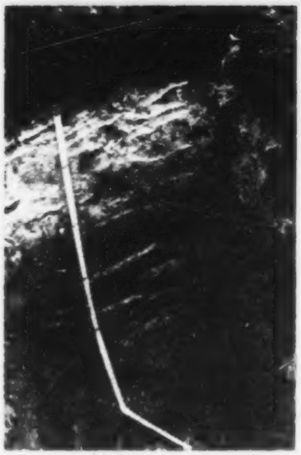
Typical vegetation

Moisture regime	poor		rich
dry	Pine, black spruce, ericaceae **1**	Spruce, white birch, red maple **4**	Beech, sugar maple, spruce, pine **8**
	Black spruce, pine, ericaceae **2**	Balsam fir, red spruce, yellow birch, red maple **5**	Sugar maple, beech, yellow birch, spruce **7**
wet	Black spruce, tamarack, sphagnum **3**		Spruce, red maple, cedar, balsam fir **6**

poor ← Nutrient regime → rich

cool ← Topoclimate → warm

The edatopic grid for New Brunswick uplands. The grid on the facing page describes ecological site types, or *ecoelements*, in terms of their soils and topographic character. The grid to the left identifies associated typical forest vegetation .



Large, flat areas of eastern New Brunswick have low relief and are underlain by clay-rich, impermeable soils (top) that lead to the formation of extensive peatlands, such as the Canaan Bog area (bottom).

For practical purposes, ecologists subdivide the continuous gradients in topoclimate, soil nutrient regime and soil moisture regime individually into discrete classes or sections. Ecological units, or elements, emerge with the study of the diverse possible combinations of sections of the topoclimatic, moisture, and nutrient gradients. The present ecological land classification uses eight basic physical soil and landform templates based on the soil moisture, nutrient, and topoclimate gradients. These templates are later used to build a set of ecosite maps for the ecoregions of the province. The two-dimensional edatopic grid presents a convenient and simple representation of topoclimate, soil moisture, and soil nutrients described above. Because nutrient regime and topoclimate are correlated, these two gradients appear together along the horizontal axis of the edatopic grid.

Keys and tables useful for identifying ecoelements in the field are provided in Appendix 1.

Major Gradients affecting Wetlands and Other Non-forested Elements

So far, we have focussed on the major gradients affecting forest composition in New Brunswick. Complementing our forested landscape is a rich array of other features and ecosystems. At higher elevations, rock outcrops and even a few subalpine barrens interrupt the forest cover, while along the coasts, sand dunes, gravel shores and mud flats are common features.

The wetlands of the province encompass the most extensive and diverse of the non-forested ecosystems. Wetland ecosystems, by definition, occur where the water table lies at or near the surface, or where shallow water – either fresh or marine – covers the land at some time during the growing season. They occupy that mysterious, transitional world between land and water. In some wetlands, the full variety of species may be partly hidden below the surface of water that nonetheless is shallow enough to give tantalizing glimpses of the life below. Few people who have ventured across a peatland on foot will forget the experience of walking on soft, soggy, spongy ground, especially if they fell through a layer of peat to take an unexpected bath! Wetlands include bogs, fens, swamps, marshes, and shallow open waters that dot the New Brunswick landscape and provide a textural contrast to our primarily forested terrain.

Wetland Gradients

The complex set of factors that shapes the character of wetlands in the Maritimes can best be summarized by describing two gradients: disturbance and flooding.

Disturbance

The disturbance gradient of a wetland is evaluated on the basis of the energy of the water that affects it, whether through wave or tidal action, ice scour, or rainfall.

Disturbance may have a profound impact on a wetland through the sorting, removal, or deposition of sand, silt or partly-decomposed organic matter. Steady flow, strong currents, wave action, and dramatic water fluctuations all prevent the accumulation of organic matter and fine particles, thus lowering the levels of nutrients available to plants. The plant species in such unprotected sites tend to be small and adapted to a high-energy environment: shrubs instead of trees, narrow spike rushes instead of robust cattails, and submerged plants with ribbon-like leaves instead of plants with large floating leaves. Where disturbance is extreme, the vegetative cover may be sparse or non-existent. Hence, the vegetation typical of gravelly shores is scattered herbaceous species.

In contrast, minimal disturbance allows the accumulation of organic material and fine sediment. This occurs in protected coves or embayments, in ponds, and along the shores of small lakes. In these situations, the associated wetland vegetation forms a thick cover of lush plants such as cattails, pickerelweed, or water-lilies. Historically, the combination of low or no disturbance, appropriate (acidic) substrate, and a cool, humid climate has been sufficient for organic matter to accumulate to impressive depths in the form of peatlands. The raised bogs common in our coastal regions have been in the making since the retreat of the last glacial seas.

Flooding

While disturbance is important, it is the 'wet' in wetland that defines the ecosystem. The flood regime can range from occasional or short floods to permanent flooding to various depths. This is, in effect, a continuation of the moisture gradient described for forest ecology. As already noted for forest soils, one of the primary

Broad, floating leaves of the bullhead-lily capture sunlight, but this morphological adaptation restricts the plant to low energy, quiet backwaters.

ecological effects of prolonged flooding is the depletion of oxygen in the soil. The oxygen is consumed by microbial activity and is normally replenished through aeration or exchange with the atmosphere. Flooding slows the rate of replenishment because oxygen diffuses much more slowly through water than through air. Shallow, moving water may be well aerated and, thus, replenish oxygen somewhat, but stagnant or slow-moving water may effectively act as a barrier to the diffusion of oxygen from the atmosphere to the soil.

The lowered oxygen levels present problems for living plants, literally drowning the roots and, in deeper flooding, the shoots of the plants. Thus, species that are typical of wetlands show a number of adaptive traits that help them cope with periods of reduced oxygen availability. An example of this kind of adaptation is the formation in aquatic plants of an especially porous plant tissue called *aerenchyma*. This kind of tissue has air spaces between cells. Scientists believe these air spaces facilitate the passage of oxygen and other gases from shoot to root. A second kind of adaptation is the formation of new roots to replace those damaged by prolonged flooding. While these two examples are morphological adaptations, other adaptations may be part of the plant's life history, such as the timing of seed release or seed germination requirements. For example, many of the wetland species in our region release their seeds in autumn, to be carried about by wind and water currents, with germination occurring the following spring as flood waters recede.

Pickerelweed can withstand slow to moderate currents.

The combination and effectiveness of these adaptations vary between species, with the result that different species display different levels of flood tolerance. Among the least tolerant are woody plants, to the extent that they are restricted to the highest portions of the wetlands where flooding is of shortest duration.

The non-woody plants cover a wide range of forms and flood tolerances, from the species that resemble terrestrial plants at the upper edge of the wetland, to the emergent species in the middle, to the floating-leafed species, or even completely submerged species in the deepest areas. It is the emergent species that most of us picture when we hear the word wetland. These are the cattails, bulrushes, and smaller plants with erect stems that often have some part of their stem or shoot in the water. They are found in the middle to lower portions of the wetland where they literally 'emerge' from shallow water. The most flood-tolerant emergents are tall, reed-like species that are able to survive prolonged periods of flooding at depths exceeding 1 m.

Some wetland sites display the full span of flood gradient from high shoreline, with only brief flooding, to areas that are flooded for much of the year. With this range in flooding comes the associated zonation of plant types, from trees and shrubs, to upper marsh species, emergents and, finally, floating-leafed and submerged species. Other wetlands are more homogenous in nature. These sites receive essentially the same depth and duration of flooding throughout and thus display less zonation of vegetation across the site.

A vegetation gradient reflecting the transition from high to low flooding and disturbance environments is depicted in the vegetation in this scene from the Eastern Lowlands Ecoregion. Low grasses and sedges line the water's edge, followed in sequence by more robust grasses and ferns, and speckled alders (tall shrubs).

Diversity of Wetland Types

The interaction of flooding and disturbance events translates into a diversity of wetland forms and vegetation, from raised bogs with their stunted shrubs to floodplains with imposing stands of silver maple. There have been many approaches to distinguishing between wetland types, some emphasizing the position of the wetland in the landscape, others the water chemistry, and still others the major vegetation types. One of the more comprehensive and practical schemes is the Canadian Wetland Classification System (CWCS) as described by the National Wetland Working Group. It is based on five major classes that capture a range of hydrology, with accompanying changes in nutrient availability, rates of decomposition, and characteristic vegetation. These are bog, fen, swamp, marsh, and shallow open water.

A simple way of distinguishing among these five classes or wetland types is to consider two broad categories: peatlands and mineral wetlands. Peatlands, defined by their thick layer of organic matter, or peat,

Sandy beaches with a broad fetch (distance over water where wind may effect wave action) are high-energy environments that typically support sparse vegetation.

Flood duration and intensity of disturbance regime

Longer flood duration ↑

<table>
<tr><td rowspan="2">Stable water levels; continually flooded; peat accumulation</td><td rowspan="2">Stable water levels; drainage restricted by channel blockage; peat accumulation</td><td>Infrequent drawdown; near shore; coves; embayments</td><td>Near continual flooding; extended fetch or strong currents</td><td>Near continual flooding; channel</td></tr>
<tr><td>Prolonged flooding; protected shore; backwater cove</td><td>Prolonged flooding; extended fetch or strong currents</td><td rowspan="2">Gravelly or bouldery shores subject to short flood events</td></tr>
<tr><td rowspan="2">Wet depressions and seeps</td><td rowspan="2">Perimeter of ponds or small lakes; limited currents and/or wave action</td><td>Seasonally flooded and protected; limited current or wave action</td><td>Seasonally flooded with significant current/wave action</td></tr>
<tr><td>Short flood events; very wet or saturated soils; intervales</td><td>Short flooding; high shore</td><td>High-energy streams; tops of banks and levees</td></tr>
<tr><td>Isolated flats or depressions</td><td>Blocked channels that drain slowly</td><td>Lakes and rivers</td><td>Lakes and rivers</td><td>High-energy streams and shores</td></tr>
</table>

Greater disturbance (ice scour or wave energy) →

The edatopic grid for wetlands in New Brunswick. The illustration above describes ecological site types in terms of their flood duration and disturbance regime intensity. The grid on the following page identifies the typical vegetation associated with those conditions.

form in areas of blocked or restricted drainage such as small depressions or where glacial or other deposits have restricted the flow of surface water. Peatlands are further divided into bog or fen, depending on the extent of peat accumulation and the nature of ground water influence. Wetlands with discernable water flow or fluctuation tend not to develop appreciable layers of peat and are, therefore, on mineral soils, hence the term mineral wetlands. Mineral wetlands are generally in the form of swamps, marshes

Typical vegetation

Longer flood duration

Isolated flats or depressions	Blocked channels that drain slowly	Lakes and rivers	Lakes and rivers	High-energy streams and shores
Bog ponds or shallow open water	Shallow open water -floating-leaved species including pond lilies		Shallow open water -submerged species	Limited vascular plants
Bogs -*Sphagnum* -ericaceous shrubs -stunted spruce	Fens -Sphagnum -ericaceous shrubs -spruce and tamarack -sedges -on calcareous sites: sedges and grasses	Low marsh -robust emergents; cattails	Low marsh -reeds and plants with basal rosettes or creeping stems	Patchy vegetation -mat-forming plants with creeping stems
		Shrubs -alder -meadow sweet	Shrubs -sweet gale -meadow sweet -willow	
Wooded conifer swamp -spruce -cedar -moss understory	Shrubs and meadows -alders -ericaceous shrubs -grasses and sedges	High marsh -robust leafy emergents	High marsh -sedges, grasses, and dicots	Shrubs and patchy vegetation
		Silver maple swamp	Poplar, willow, and red ash	Balsam poplar and willow

Greater disturbance (ice scour or wave energy) →

The edatopic grid for New Brunswick wetlands. The illustration above describes the typical vegetation makeup for the flooding duration and intensity of disturbance regime described by the grid on the facing page.

(either coastal or freshwater), or shallow open water. We shall examine each wetland type in turn, beginning with the two peatland types.

Peatlands

Peatlands are essentially living carpets of mosses and other plants overlying layers of older, partly decayed organic material. Their development results from the gradual accumulation of these older plant materials, whose decomposition rate is slowed by acidic

A true bog with stunted black spruce trees. The shrub layer is dominated by species of the family *ericaceae*, which includes blueberry and lambkill.

conditions, cool temperatures, and the low oxygen levels that result from saturation or standing water. At a continental scale, New Brunswick is in a zone where the surface vegetation and the partially decayed plant material are composed mostly of *Sphagnum* mosses. Peatlands have been developing in New Brunswick since the most recent glacial retreat 11,000 years ago, and in places the depth of accumulated peat has reached 9m above the underlying mineral soil.

The visual appearance of peatlands varies markedly from one region to another. They may be dome-shaped or relatively flat. They can be surrounded by a well defined depression called a lagg, or by shrub swamp or marsh, to form a wetland complex. Pools on their surface can appear in varied sizes and may be arranged either linearly or randomly. Some surfaces are undulating, with hummocks and depressions, whereas others display a virtual lawn of colourful mosses and sedges.

Bogs

As organic matter accumulates in a peatland, its living surface gradually rises above the influence of the groundwater table. If the surface vegetation reaches the point of being isolated from groundwater, then rainfall and other atmospheric deposition become the only sources of nutrient input. Such peatlands are called ombrogenous (nourished only by rain) systems and, by definition, are true bogs. The low nutrient availability explains the nature of the vegetation: small or relatively slow-growing species that are capable of storing resources over long periods. These include mosses, lichens, low evergreen shrubs (such as leather-leaf and Labrador-tea), and stunted spruce or tamarack.

In addition to ericaceous shrubs, fens typically support grasses and sedges in greater abundance than do bogs.

Fens

If the surface vegetation of a peatland maintains at least some contact with flowing water that has contacted mineral substrates, it receives nutrients from those substrates. These peatlands are called fens. Fens contrast with bogs, where the only water input to the surface vegetation layers comes from precipitation. In fens, lateral flow and contact with mineral substrates tend to reduce acidity of the water and to increase oxygenation. Whether a peatland develops into a bog or remains a fen is determined by the extent of water flow and fluctuation, and by water chemistry.

Fens cover a wide range of nutrient conditions and their vegetation varies accordingly. Where mineral nutrients are in short supply, many of the species characteristic of bogs are present. On sites with rich ground water input, distinctive plant assemblages are found. Some features of these rare and rich sites include the presence of brown mosses, in addition to *Sphagnum*, and also more nutrient-demanding plants: shrubby cinquefoil, sedges (such as livid sedge), and some stunning orchid species, including grass-pink and swamp-pink (dragon's mouth). Most New Brunswick peatlands may be subdivided into true bogs and nutrient-poor fens. Raised bogs often exist side by side with sections of fen that merge into shrub swamp or some other non peat-forming system.

A peatland composed of two domed bogs separated by an alder swamp growing alongside a low energy stream (flowing left to right). Lying between the green bog and the stream is the fen zone (yellow-brown colour).

Mineral Wetlands

The environment of wetlands along active streams, rivers, or large lakes is not conducive to peat formation and, instead, gives rise to non-peat-forming systems. These fall into any of three wetland types: swamp, marsh, or shallow open waters, the last of which represents small bodies of standing water that are transitional to ponds or lakes. Swamp occurs on the highest portion of the shore, while shallow open waters may be scattered throughout or at the edge of the deepest marsh.

Swamps

Swamps are recognized by the dominance of woody vegetation and include both shrub-covered and forested wetlands. The range in cover type reflects a gradient from the brief, high-energy episodes of runoff along streams to the extended periods of flooding or soil saturation in the floodplains of large rivers. Shrub swamps often occur along meanders of streams or small rivers, sometimes consisting of only a narrow band of alder with meadow-sweet, dogwood, or other shrubs. Where the substrate remains moist for longer periods, alder swamps often support a rich understorey of

This silver maple swamp has a dense understorey of sensitive fern and the ostrich fern, more commonly known as the popular wild food, the fiddlehead.

ferns, sedges, violets, and other species. Along lakeshores, extensive cover by sweet gale is more common.

The abundance of streams and small rivers in the province creates a large number of areas suitable for the development of shrub swamps. However, the collection of streams over large distances necessarily creates rivers, and it is along the shores of major watercourses that we are more likely to find the distinctive treed swamps dominated by silver maple. Imposing stands of silver maple are found along the lower Saint John River and Oromocto River floodplains, as well as along other waterways that roll into the Grand Lake Lowlands. These silver maple swamps are perhaps the most regionally significant wetland type in the province. Although they are characteristic of floodplains in the southern parts of Ontario and Québec, they are absent elsewhere in the Maritimes. Away from the lowland river valleys, treed swamps also occur in uplands where soil drainage is poor. On acidic and oxygen-poor sites, these swamps are typically dominated by tamarack or black spruce and bog-like understorey vegetation; where the soils are less acidic and relatively well oxygenated, they may be dominated by various combinations of eastern white cedar, white spruce, red maple, and black ash.

Freshwater Marsh

Marshes are perhaps the most commonly recognized type of wetland. Home to fish, waterfowl, frogs, and muskrat, they are transitional in flooding duration and depth between the less inundated swamps and the more submerged shallow water wetlands. The so-called high marsh, or meadow, experiences intermittent or seasonal flooding, whereas low marsh undergoes prolonged or permanent flooding. Some of the largest wetland complexes in the province are marsh, with dominant vegetation consisting of robust emergent species such as cattail, river bulrush and soft-stem bulrush.

Cedar swamps have a relatively short period of flooding compared with silver maple swamps.

Coastal Marsh

Coastal marshes are found in saline, coastal settlings that are sufficiently protected from wave action to allow for the accumulation of sediment and organic matter. They are characterized by species known as *halophytes* that are adapted to periodically flooded, saltwater environments.

Freshwater marsh dominated by cattails. *Photograph courtesy of Ducks Unlimited Canada.*

As with their freshwater equivalents, saltwater marshes are divided into high and low marsh. High salt marsh generally lies above the mean high tide and is flooded only during the highest tides. Low salt marsh sits below the mean high tide and receives the daily tides. Low marsh, in particular, is an uncommon and vulnerable habitat, subject to reshaping by ice, storm, and wave action. In low marsh, the number of vascular plants species is generally low. Salt-water cordgrass is most often the dominant vegetation. Salt-meadow grass is common in high marsh where it is often the major element in a mosaic with arrow-grass, glasswort, sea-milkwort, sea-lavender, seaside plantain and other salt and flood tolerant plants.

A coastal marsh, near Cocagne, Eastern Lowlands Ecoregion.

Much of New Brunswick's salt marsh no longer exists, having been protected from flooding by earthen dikes to make the land available for agriculture. In other places, salt marshes have been filled in to make the land suitable for buildings. Some of the largest remaining salt marsh complexes lie at the head of the Bay of Fundy and along the Northumberland oast, where they are a favourite haunt of birdwatchers eager for sightings of uncommon and migrating bird species.

Shallow open water wetland type, Valley Lowlands Ecoregion. On average, waters here are less than 1 m deep.

Shallow Open Water

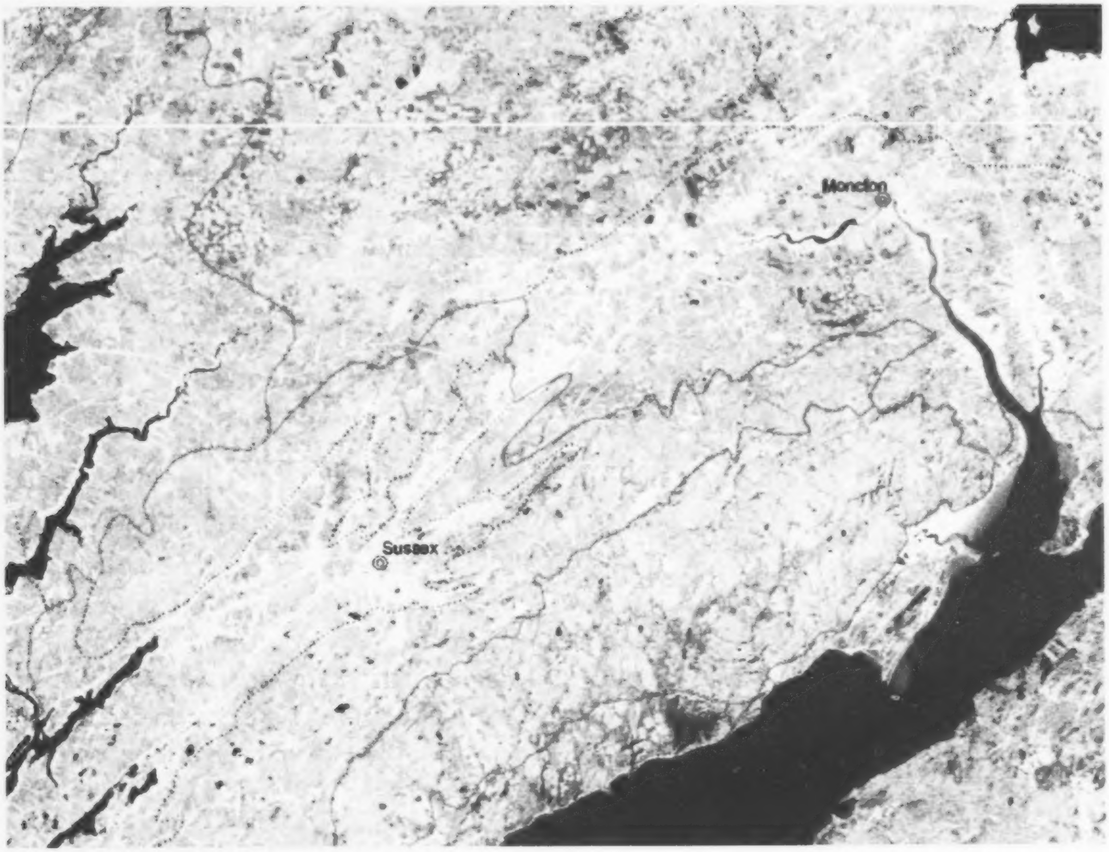
It may seem unusual to refer to shallow open water as a wetland type. The definition best fits relatively small bodies of standing water, where the vegetation consists of floating-leafed or submerged species, with only limited presence of emergent species. In our context, the term *shallow open water* may be extended to areas along lakes or rivers that fit this description and, thus, includes both isolated depressions and elements of larger wetland complexes. Shallow open water generally occurs where flooding is of a depth or duration that precludes cover by emergent species; that is, flooding for 70% to 100% of the growing season, to summer depths of up to two metres.

The End of Our Ecological Story

The ecological gradients described in this chapter provide the basis for recognizing and, to some extent, explaining the ecological variation that may be seen when looking over a landscape from a good vantage point or flying over it at a low altitude. We have reviewed some examples of how species and ecosystems are distributed across the landscape, in terms of their underlying biotic and abiotic processes, and why in New Brunswick these patterns may be important in adapting forest and wetland management to address conservation of biological diversity.

The physical landform-soil template, or edatopic grid, is the basis for variation in forest composition and rates of ecological processes at the ecosite level of classification. Wetland types have been described in this chapter in some detail to show their variation with respect to gradients of disturbance and flooding.

In the next chapter, we will build on the discussion presented here, moving from general patterns to specific instances as we further examine the distribution patterns of forest species, forest types, and wetland types as they relate to the physical attributes of New Brunswick's ecoregions.



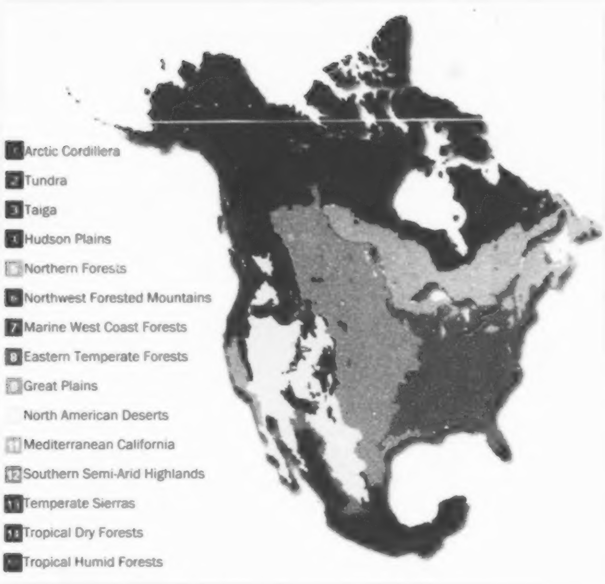
The view of the inner Bay of Fundy from the Landsat 7 satellite reveals the emergence of ecoregion-scale patterns. *2003 ©Government of Canada with permission from Natural Resources Canada.*

Chapter 6

Overview of New Brunswick Ecoregions

The previous chapter presented the concept of ecological gradients, relating the distribution of species and ecosystems to landscape characteristics such as topoclimate, soil moisture, soil nutrient regimes, wetland flooding, and wetland disturbance. The information provided the general principles that underlie ecological land classification in New Brunswick.

The present chapter introduces the seven New Brunswick ecoregions, those being the Highlands, Northern Uplands, Central Uplands, Fundy Coast, Valley Lowlands, Eastern Lowlands, and Grand Lake ecoregions. Ecoregions are defined primarily by their climatic differences as shaped by major landforms, elevation, latitude, marine influences, and broad aspect. Ecoregions


Arctic Cordillera
Tundra
Taiga
Hudson Plains
Northern Forests
Northwest Forested Mountains
Marine West Coast Forests
Eastern Temperate Forests
Great Plains
North American Deserts
Mediterranean California
Southern Semi-Arid Highlands
Temperate Sierras
Tropical Dry Forests
Tropical Humid Forests

The ecological regions of North America, as determined by the Commission on Environmental Cooperation. *Source: www.cec.org.*

also are distinguished on the basis of species distribution patterns influenced by the various climate-related factors.

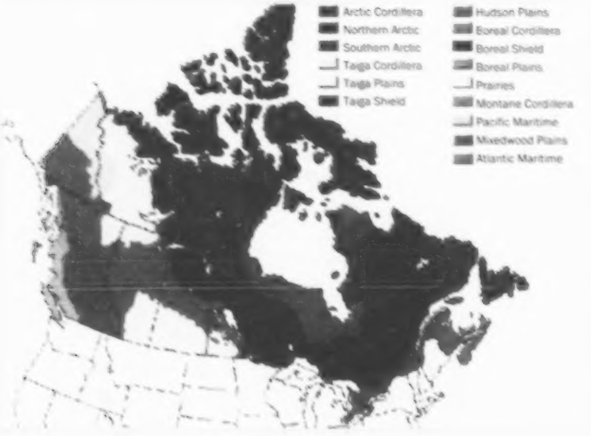
In this chapter, we briefly compare the ecoregions in terms of their climatic differences, distribution of forest vegetation species, distribution of wetlands, distribution of animal species; and species phenology.

Climatic Differences

At the continental scale, climate is the overriding influence that determines which areas of North America are forest, grassland, desert, tundra, or other ecosystem type. Three major subdivisions of forests in eastern North America have been recognized: the subtropical forest of southern Florida, the temperate broad-leaved forest covering most of the eastern United States and extending into Canada, and the boreal forest (taiga) of Québec, Ontario, Newfoundland, and Labrador. New Brunswick falls within the temperate broad-leaved forest category but is situated far enough north to have several boreal elements, including the prominence of balsam fir, jack pine, tamarack, and spruce species.

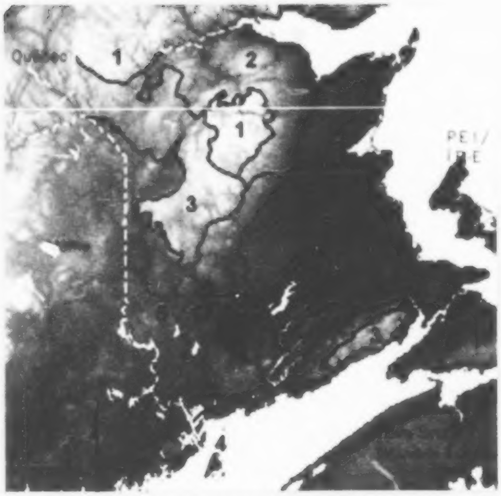
Since the immediately post-glacial period, the Appalachian Mountains have remained above sea level and thus have served as an effective north–south migration corridor. This has resulted in a blending of northern and southern floral and faunal elements in the Atlantic region. The unique mixture of forested and non-forested ecosystems in the Maritimes has been recognized by Canadian and North American classification frameworks as a definable forest region called the Acadian Forest or, more recently, the Atlantic Maritime Ecozone.

The terrestrial ecozones of Canada, developed by Environment Canada.


Arctic Cordillera
Northern Arctic
Southern Arctic
Taiga Cordillera
Taiga Plains
Taiga Shield
Hudson Plains
Boreal Cordillera
Boreal Shield
Boreal Plains
Prairies
Montane Cordillera
Pacific Maritime
Mixedwood Plains
Atlantic Maritime

In New Brunswick, the climatic gradients characteristically are determined by a combination of elevation above sea level and proximity to the ocean. The Fundy Coast Ecoregion is strongly influenced by effects of the cool Bay of Fundy. Elsewhere, the mean temperature tends to decrease with increasing elevation.

Precipitation in the Fundy Coast Ecoregion is high relative to other ecoregions, except in late summer. The driest ecoregion is the Northern Uplands Ecoregion, which lies in the rain shadow of the highlands of the Gaspé region. The Central Uplands Ecoregion has high mean precipitation values, but this average obscures an important difference between the two, geographically separate, areas that make up the ecoregion: the Madawaska Uplands in the north and the Caledonia Uplands in the south. The Caledonia Uplands are proximal to the Bay of Fundy; their precipitation is consequently higher than in the Madawaska Uplands, approaching that of the Fundy Coast Ecoregion.

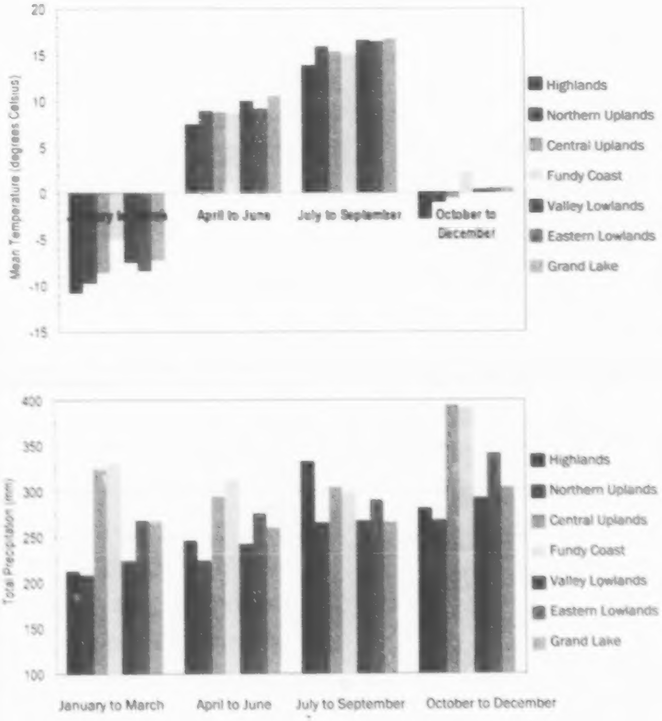


Ecoregions. 1—Highlands, 2—Northern Uplands, 3—Central Uplands, 4—Fundy Coast, 5—Valley Lowlands, 6—Eastern Lowlands, 7—Grand Lake. Higher elevation land denoted by lighter shades .

Distribution of Forest Trees

The distribution of forest tree species in New Brunswick is well know relative to that of other species in the province, because its forests have long been the object of intensive survey efforts. High-quality inventory data exist for the more common commercial species. The provincial data set used to generate the maps and figures in this report (that is, the forest inventory survey data) incorporates field information gathered from approximately 20,000 forest stands.

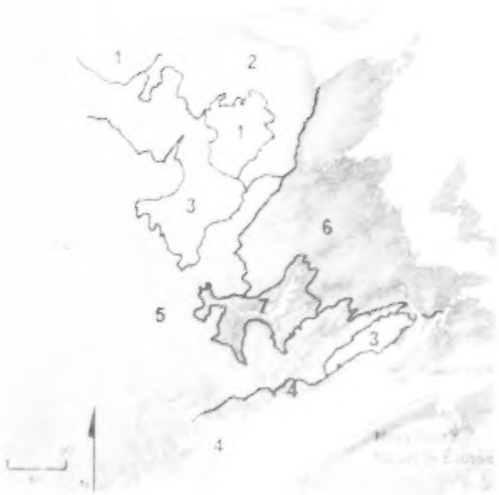
Mean temperature (top) and total precipitation (bottom) by season for the New Brunswick Ecoregions. *Environment Canada data.*



Needle-leaved Species

At the broadest scales, it is interesting to note the widespread distribution of both red spruce and balsam fir throughout the province, especially the prevalence of fir in the north and northwest, as compared with the predominance of red spruce in the east and southwest. The continental range of red spruce extends north to the southern Gaspé Peninsula and the north shore of the mean temperature tends to decrease with increasing elevation.

Precipitation in the Fundy Coast Ecoregion is high relative to other ecoregions, except in late summer. The driest ecoregion is the Northern Uplands Ecoregion, which lies in the rain shadow of the highlands of the Gaspé region. The Central Uplands Ecoregion has high mean precipitation values, but this average obscures an important difference between the two, geographically separate, areas that make up the ecoregion: the Madawaska Uplands in the north and the Caledonia Uplands in the south. The Caledonia Uplands are proximal to the Bay of Fundy; their precipitation is consequently higher than in the Madawaska Uplands, approaching that of the Fundy Coast Ecoregion.



Ecoregions: 1 Highlands, 2 Northern Uplands, 3 Central Uplands, 4 Fundy Coast, 5 Valley Lowlands, 6 Eastern Lowlands, 7 Grand Lake. Higher elevation [illegible]

Distribution of Forest Trees

The distribution of forest tree species in New Brunswick is well know relative to that of other species in the province, because its forests have long been the object of intensive survey efforts. High-quality inventory data exist for the more common commercial species. The provincial data set used to generate the maps and figures in this report (that is, the forest inventory survey data) incorporates field information gathered from approximately 20,000 forest stands.

Needle-leaved Species

At the broadest scales, it is interesting to note the widespread distribution of both red spruce and balsam fir throughout the province, especially the prevalence of fir in the north and northwest, as compared with the predominance of red spruce in the east and southwest. The continental range of red spruce extends north to the southern Gaspé Peninsula and the north shore of the

Mean temperature (top) and total precipitation (bottom) by season for the New Brunswick Ecoregions. Environment Canada data.

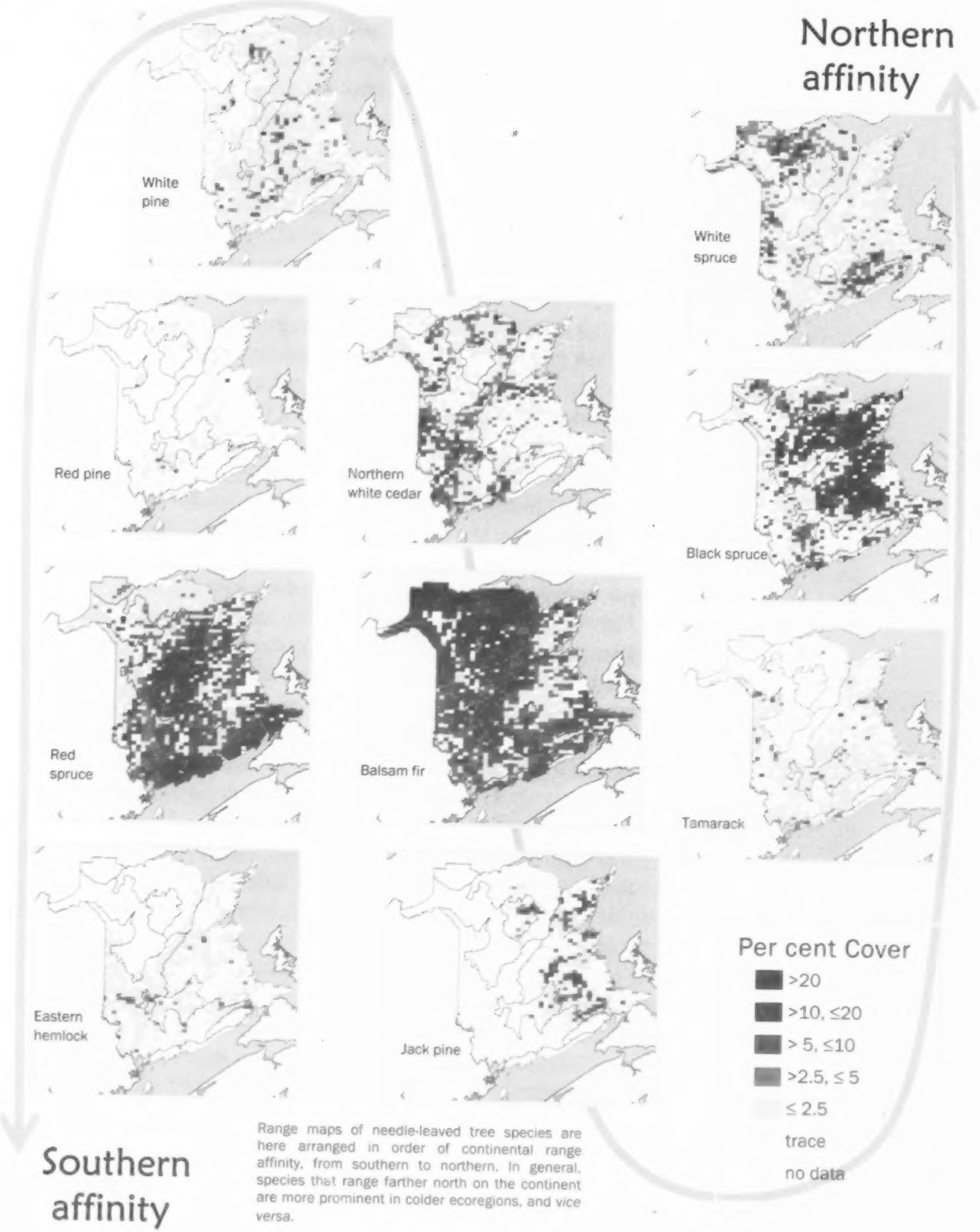
St. Lawrence River, and south through New England as far as Massachusetts. Beyond this most southerly point, only scattered populations exist as far south as the Great Smoky Mountains in North Carolina.

It is therefore not surprising that in New Brunswick, red spruce is a predominant conifer species in the climatically warmer, lower elevation areas. Soil factors may also come into play, since red spruce is more tolerant than balsam fir of the acidic soil conditions that predominate in the Eastern Lowlands Ecoregion. In contrast, the range of balsam fir stretches from southern Maine, as far north as 55° latitude in Québec and west-central Canada; it is correspondingly more prevalent in the higher-elevation, cooler areas of the province.

On a continental scale, white spruce is clearly a boreal species. It is typically found on calcareous soils throughout the north as far as the tree line, and as far west as Alaska. In New Brunswick, it is a frequent stand component in the cool Northern Uplands and Highlands ecoregions, especially on soils derived from calcareous parent materials. In southern New Brunswick, it is an important species on former fields and pastures. Only on old fields does white spruce grow naturally in pure stands in New Brunswick.

Black spruce is a species typical of the far north of Canada, dominating the boreal forest as far north as the treeline. This area of Canada is known for the high frequency and extent of forest fires, and black spruce is specially adapted to cope with wildfires. In fact, black spruce cones will open and release seed on the burned ground, in response to the heat generated by a fire. Thus, seed scattered under a burned stand can regenerate a new stand of black spruce. Jack pine employs a similar strategy, while mature individual trees of white and red pine often survive a wildfire, due to thick bark which protects the living, delicate cambium tissues underneath from otherwise lethal temperatures. Survivors then scatter seed on the burned ground, and are re-established in this way.

In New Brunswick, black spruce is common where soils are naturally wet, peaty, and acidic such as in much of the Eastern Lowlands Ecoregion, and in the areas east of the Highlands Ecoregion. In the Central Uplands Ecoregion portion of black spruce's range, however, natural occurrences are limited to sites that are unsuitable for most other tree species. These include dry, rocky sites, and very wet, peatland sites. This combination of


Northern affinity
White pine
White spruce
Red pine
Northern white cedar
Black spruce
Red spruce
Balsam fir
Tamarack
Eastern hemlock
Jack pine
Per cent Cover
>20
>10, ≤20
> 5, ≤10
>2.5, ≤ 5
≤ 2.5
trace
no data
Southern affinity

Range maps of needle-leaved tree species are here arranged in order of continental range affinity, from southern to northern. In general, species that range farther north on the continent are more prominent in colder ecoregions, and *vice versa*.

ecological and climatic factors leads to the prevalence of black spruce and pine species in the Eastern Lowlands Ecoregion. These species also predominate in some of the fire-prone, rocky, steep-sided, or east-west-oriented river valleys of the Upsalquitch and Nepisiguit rivers, and on the low elevation, wet, acidic, flatter landscapes located south of the lower Tobique River.

A map of the distribution and abundance of pine species indicates the areas of the province that, at least in post-colonial times, have been fire-prone. The Eastern Lowlands and Grand Lake ecoregions show a strong presence of pine, as does the Nepisiguit River Valley, in the Highlands Ecoregion. The steep-sided Upsalquitch River valley in the Northern Uplands Ecoregion is also a hot spot for pine. Large, pure stands of red and white pine have persisted in this area, despite heavy logging of river valleys during the last two centuries. In contrast, the prevalence of pine is low in the Central Uplands Ecoregion and along the Fundy Coast Ecoregion. Three portions of the Valley Lowlands Ecoregion are still important for pine: parts of the lower Tobique valley; the areas south and west of Fredericton on acidic glaciofluvial deposits and on similarly dry stony or rocky soils; and on the Anagance ridges, east of Sussex.

Eastern hemlock is a shade-intolerant conifer species whose continental distribution dips the farthest south of any native conifer, into northern Georgia and Alabama. In New Brunswick it is situated at the northern limit of its geographic range. Except for a few outlying populations, hemlock is restricted to the lowland ecoregions: the Valley Lowlands, the Grand Lake Ecoregion, and the Eastern Lowlands Ecoregion. It is virtually absent from the cool Fundy Coast Ecoregion.

Eastern white cedar is capable of tolerating a wide range of soil conditions, but does best on moist to wet soils that are less acidic than average. On calcareous sites, cedar regenerates prolifically on exposed mineral soil. Cedar is more prominent in New Brunswick than eastern hemlock. It is particularly abundant in the Valley Lowlands Ecoregion, especially on soils derived from calcareous soil parent materials. Its abundance is particularly noticeable in a section of the Eastern Lowlands Ecoregion near Rogersville, where glacial transport has brought diverse rock types, including calcareous fragments, from the higher ground to the west, thus enriching the soil for cedar.

Tamarack is a distinctive conifer that sheds its needles each fall. In the southern portions of its continental range, tamarack is most abundant on very wet sites, and both on or surrounding peatlands, but is less common on better drained sites. Tamarack is widely distributed in New Brunswick. The relatively good drainage of the upland and Highlands Ecoregion may explain why tamarack is scarce there, despite an obvious affinity for high latitudes on this continent. Tamarack is also an important species on old-field sites in the Grand Lake, Valley Lowlands, and Eastern Lowlands Ecoregions.

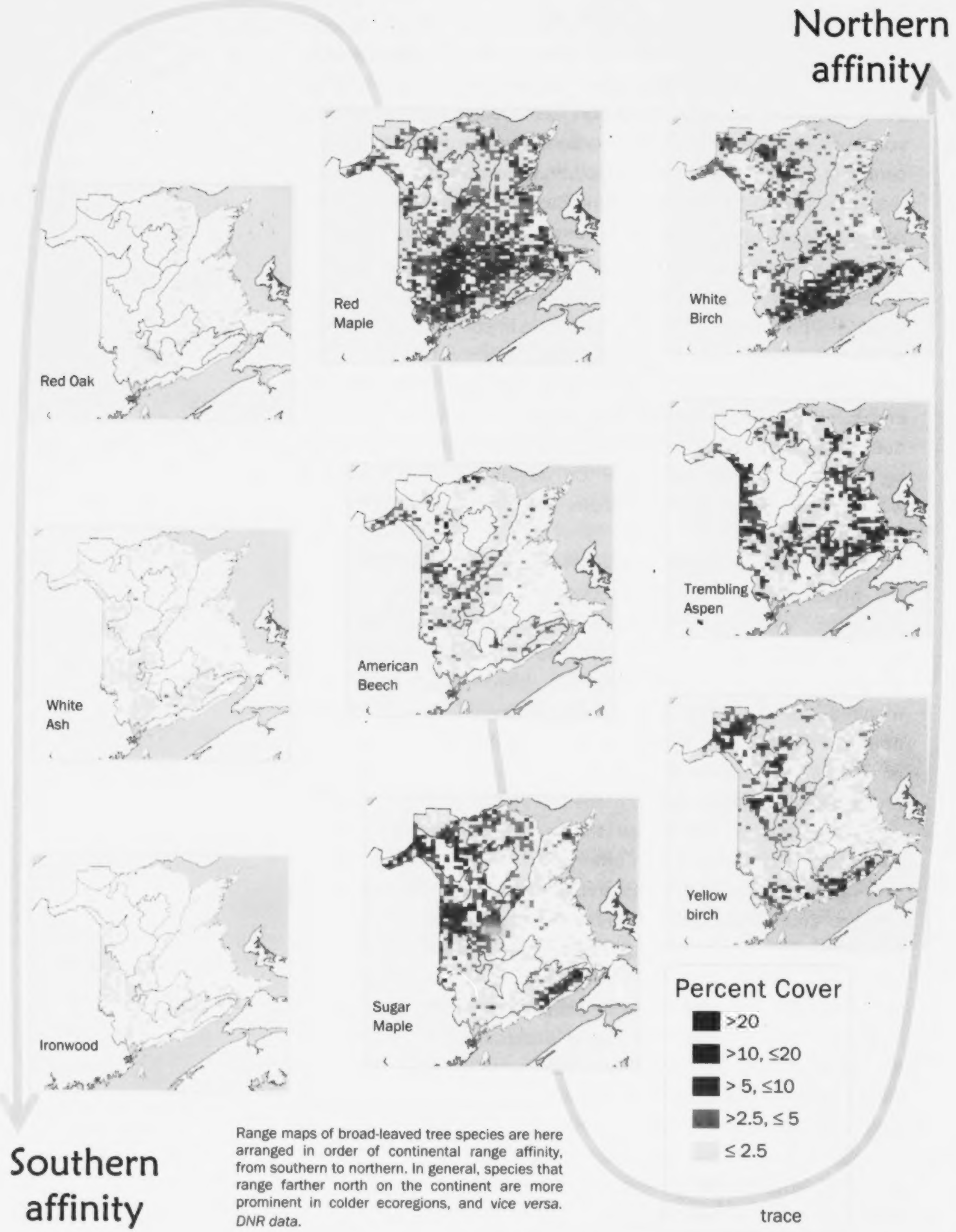
Broad-Leaved Species

The shade-tolerant hardwoods are best represented today in west-central and northwestern New Brunswick. The predominance of tolerant hardwoods in these areas is due in part to good drainage, fertile soils, and relatively infrequent fires . Historically, much of the Valley Lowlands Ecoregion supported shade-demanding hardwood and softwood species. Today, much of the low-elevation, low-relief area along the Saint John and Kennebecasis rivers now supports agriculture alongside a patchy or fragmented distribution of woodlands dominated by red maple, white spruce, and intolerant hardwood species.

Yellow birch and sugar maple are widely distributed throughout the province, but are most abundant in the Central Uplands Ecoregion. Ironwood is also common shade-tolerant hardwood species, whose range conforms quite well to the boundaries of the Valley Lowlands and Grand Lake ecoregions. Continentally, it is found as far south as mountainous areas of Central America. Ironwood and black cherry have the most southerly range extension of all New Brunswick tree species. This possibly explains why they favour the warmest ecoregions of the province.

White ash is widespread throughout the Valley Lowlands Ecoregion, in association with other tolerant hardwoods on ridges. Only rarely does it form pure stands. It is also commonly associated with well drained, coarse soils on freshwater beaches, accompanied by red oak. Red maple is a frequent associate of sugar maple, yellow birch, and beech in tolerant hardwood stands. Where the soil is too acidic to support these associated species, red maple is still found in abundance on hilltops and ridges, especially in the Grand Lake and Eastern Lowlands ecoregions. It also can regenerate prolifically from both seed and stump sprouts in clearcuts and is therefore an important component of cutovers and of shade-intolerant hardwood stands, especially in the three lowland ecoregions.

The distribution of the shade-intolerant hardwood species such as white birch and trembling aspen typically indicates where fire,


Northern affinity
Red Oak
Red Maple
White Birch
Trembling Aspen
White Ash
American Beech
Ironwood
Sugar Maple
Yellow birch
Percent Cover
>20
>10, ≤20
> 5, ≤10
>2.5, ≤ 5
≤ 2.5
trace
Southern affinity

Range maps of broad-leaved tree species are here arranged in order of continental range affinity, from southern to northern. In general, species that range farther north on the continent are more prominent in colder ecoregions, and *vice versa*. *DNR data.*

logging, and farming have been a major influence on the character of the landscape. Intolerant hardwood species die out in absence of natural or human disturbances that create large forest openings. In this regard, it is interesting to note the low abundance of aspen in the Central Uplands, Fundy Coast, and Highlands ecoregions. It has been suggested that the low frequency of major fires in the Central Uplands and the Fundy Coast ecoregions has limited the opportunity for aspen to expand its range. Similarly, in the Highlands Ecoregion, aspen is common only near the relatively low-elevation and frequently burned Nepisiguit River Valley.

Forest Understorey Species

The range and attributes of some forest species both reflects and defines the ecological character of the province's ecoregions.

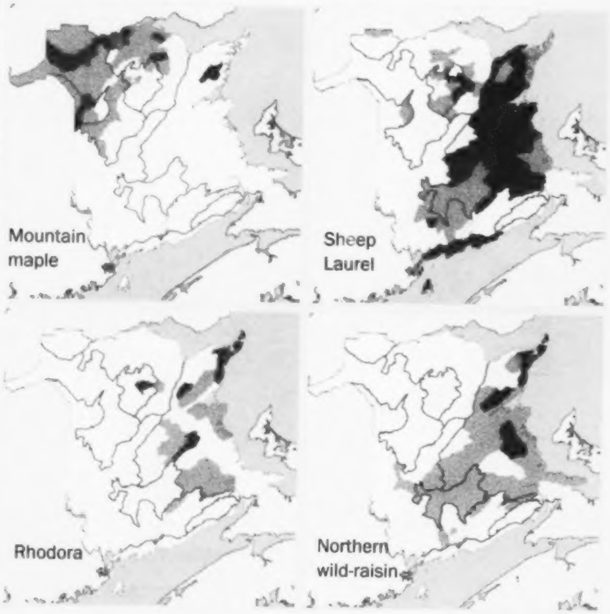
The distribution of understorey plants is not as well understood or documented as commercial tree species. Data used to compile the maps used in this report were recorded on sample plots from approximately 5000 stands province-wide. Technicians recorded understorey plant species and abundance on the sample plots. Two hundred forest plant species or species groups were identified in these surveys.

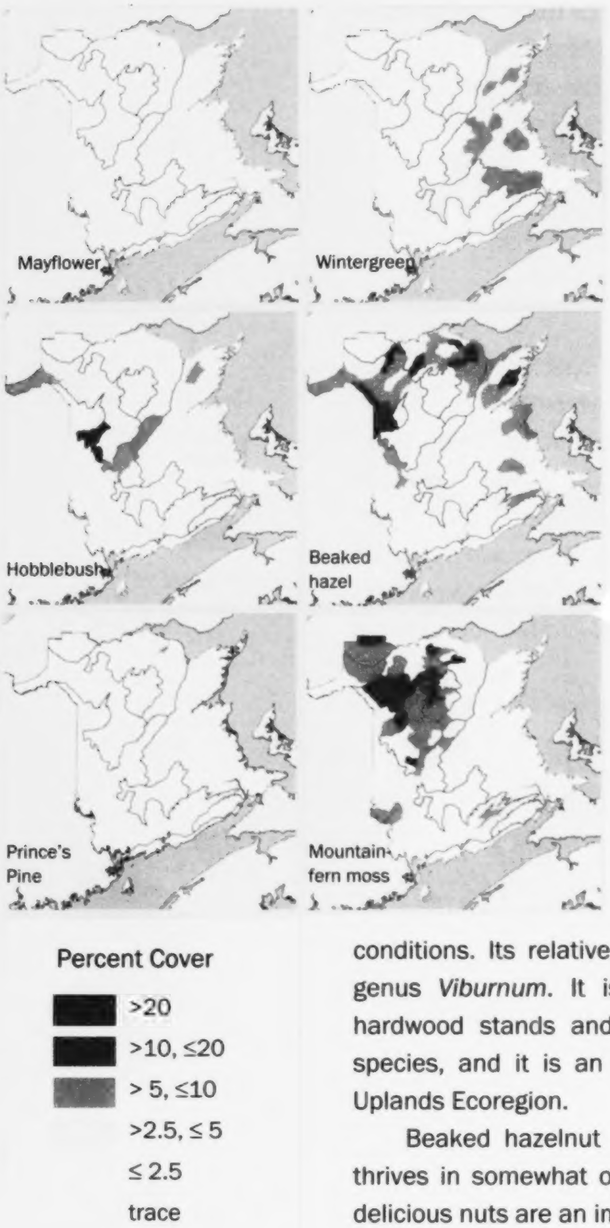
The species range maps shown here were selected from those that best conformed to ecoregion boundaries and contributed toward their distinctive stand-level "look" or ecological character of the region. In this regard, the species whose ranges are depicted may be considered representative of an ecoregion or of the predominant ecosite conditions that exist there.

Mountain maple is a shrubby tree, the smallest of our five native maple species. It is an important stand component in mixed stands of the Highlands Ecoregion and the two upland ecoregions. Creation of large forest canopy gaps in these ecoregions has resulted in a proliferation of mountain maple and an associated reduction in the abundance of more valuable timber species such as yellow birch or sugar maple. However, mountain maple is a preferred browse species for moose and deer.

Percent Cover

■ >20
■ >10, ≤20
▨ > 5, ≤10
>2.5, ≤ 5
≤ 2.5
trace





Sheep-laurel is a shrubby evergreen species with colourful pink flowers that bloom in summer. The range of sheep-laurel is indicative of the occurrence of acidic and frequently burned sites. It is common in most of the Eastern Lowlands Ecoregion. Rhodora is a related member of the family *Ericaceae* that includes such familiar plants as blueberry and some acid-loving horticultural varieties of exotic rhododendron and azalea. Rhodora's distribution further demonstrates the acidic nature of soils in the Eastern Lowlands Ecoregion and in some of the areas of the province underlain by granite rock.

Mayflower, the fragrant early bloomer often sold at farmers' markets, and wintergreen, a plant from which wintergreen-flavoured candy gets its name, are somewhat similarly distributed.

Another widespread understorey species in New Brunswick is the northern wild raisin, so named because it bears dark blue or black fruit that become slightly withered with the arrival of winter. It is another acid-loving, deciduous shrub species, although it is more widespread and tolerant of moderately acidic conditions. Its relative, the hobblebush, is also a member of the genus *Viburnum*. It is an understorey shrub found in tolerant hardwood stands and mixedwood stands of shade-tolerant tree species, and it is an important stand component in the Central Uplands Ecoregion.

Beaked hazelnut is a widespread, tall deciduous shrub that thrives in somewhat open areas on dry and less acidic soils. The delicious nuts are an important food source for wildlife and are often sold in late summer at roadsides. Beaked hazelnut is especially frequent and locally abundant in the Northern Uplands Ecoregion.

Prince's pine is a low shrubby forest species known for its affinity to dry sites. It is rare in the Highlands, Fundy Coast, and the Central Uplands ecoregions, but is more frequent in the relatively dry Northern Uplands Ecoregion, and is also relatively abundant in the

Eastern Lowlands, Valley Lowlands, and Grand Lake ecoregions.

Mountain-fern moss avoids dry areas but abundant on well-drained sites with abundant precipitation. It is common throughout the province in coniferous woods, but is particularly abundant in the understorey of spruce-fir stands in the Highlands and Central Uplands ecoregions.

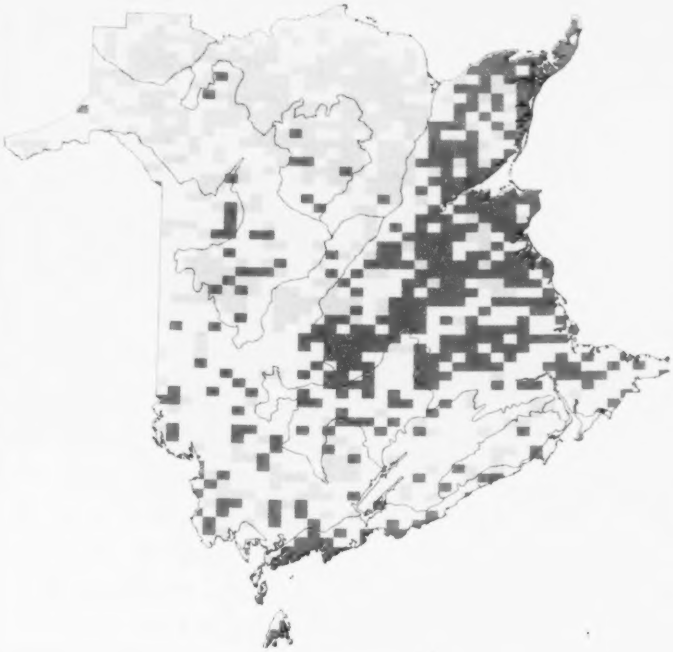
Distribution of Wetlands

The unique landscape and species diversity of each New Brunswick ecoregion may also be defined in terms of its non-forested components. The most significant of these are wetland ecosystems.

As mentioned earlier, the ecoregions of the province reflect the combined effects of elevation, climate, and topography. Not surprisingly, some of these biophysical factors also affect both the distribution and composition of wetlands. At one end of the gradient is the more rugged terrain and cool, wet climate of the Highlands Ecoregion. Wetlands in this ecoregion constitute a very small percentage of the landscape, tend to be limited in size, and are typically streamside shrub swamps. The controlling factors are (1) the rapid drainage of the steep slopes, and (2) the comparatively short duration of flood events on small headwater streams and swift, steep-banked rivers, which tend to create localized, disturbance-induced riparian wetlands.

Within the lowland ecoregions are extensive areas of low elevation and/or low relief; wetlands comprise a greater share of the area of these ecoregions. Nearly half of the province's wetlands, consisting principally of large peatlands that formed in shallow basins, are found in the Eastern Lowlands Ecoregion.

The Valley Lowlands and Grand Lake ecoregions share the dramatic influence of major watercourses and large lakes, which create the required conditions for an impressive diversity of wetland types. Most significant is the large volume of

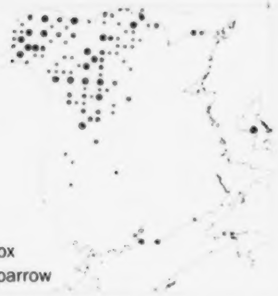


water moving through the lower St. John River and Grand Lake systems which results in prolonged flood periods over the extensive floodplains and shorelines. The interaction of these flood events with the varied topography of these ecoregions creates a wide spectrum of flood and substrate conditions, with a corresponding diversity of wetland types including silver maple swamps.

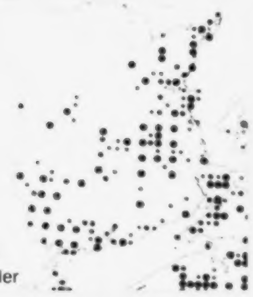
The Fundy Coast Ecoregion also presents a provincially unique situation with regard to wetlands. Despite the rugged terrain, the cool maritime climate has promoted development of impressive coastal bogs described and illustrated in Chapter 7. Coastal marshes have developed in low, protected sites behind dunes, or where rivers and streams drain across low, flat terrain into the sea. These conditions are found most noticeably along the Northumberland Strait, which shapes the shores of the southern portion of the Eastern Lowlands Ecoregion, and along Shepody Bay and the Isthmus of Chignecto in the Fundy Coast Ecoregion.

Selected Maritime Breeding Birds

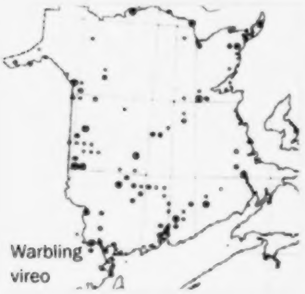
- ● Breeding confirmed
- • Breeding probable
- · Breeding possible



Fox sparrow



Palm warbler



Warbling vireo

Source: *Erskine 1992.*

Distribution of Animal Species

For many New Brunswickers, the word "wildlife" evokes images of moose, deer, or bear, charismatic species, that are large and often conspicuous. Yet, they represent only a fraction of the roughly fifty mammal species found in the province, and a vastly smaller proportion of the total number of animal species when include other vertebrate groups (fishes, amphibians, reptiles, birds) and the large number of invertebrate groups (insects, molluscs, and others). The distributions of species in this large and diverse group range from well known to nearly unknown. However, the current document considers only very few of the animal species among those whose distribution and abundance would indicate ecoregion-scale differences.

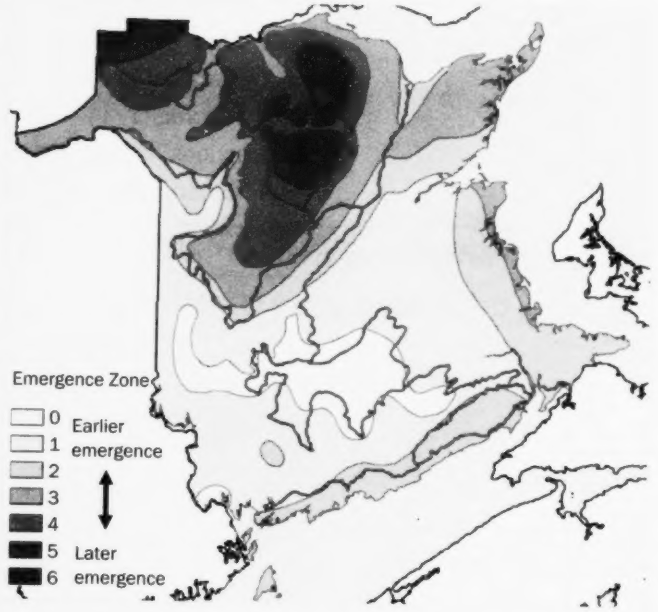
Climate and topography combine to create a north-south gradient in animal distributions, contrasting the cool Highlands and Uplands Ecoregions with the warmer and drier Lowlands Ecoregions. We might expect these trends to be most obvious in species that have minimum control over body temperature, such as fishes and amphibians. In fact, the abundance and species richness of amphibians is higher in the warm Grand Lake Ecoregion than in other ecoregions. Moreover, there are species that are found exclusively, or are more abundant, in either the northern or the southern part of the province. These species are generally at the southern or northern limit of their range, respectively, in New

Brunswick. The mink frog, for example, is relatively abundant in northern New Brunswick, reflecting its northern continental distribution; it is found from Labrador and the Maritimes to Manitoba, but does not occur farther south than the Great Lakes states. On the other hand, the bullfrog is largely absent from northern New Brunswick, but is common in the south. Continentally, it occurs throughout eastern North America from Québec and the Maritimes, as far south as Florida and Texas.

Fox sparrow is found in New Brunswick at the southern limit of its range , and breeds primarily in the Highlands and Uplands ecoregions. Palm warbler breeding conforms with the distribution of large peatlands (Lowlands ecoregions). Warbling vireo, associated with the broad-leafed forest, is restricted to warm inland valleys in our region.

Insect Phenology and the Spruce Budworm

Biological processes also vary significantly from one ecoregion to the other, including the group of processes related to species phenology. Species phenology describes the intricately controlled steps that govern the timing of plant and animal development, and that proceed similarly in all individuals of a given species. The timing of phonological processes can be affected by factors such as light or temperature, but the processes relevant to our discussion here are those influenced by climate.



Spruce budworm spring emergence zones. Ecoregion boundaries are shown as red lines. The was refined using a variety of additional data. An aerial survey of selected seasonal events determined the dates when ice disappeared from lakes, snow melted from forests, hardwoods leafed out, pin cherries flowered, and balsam fir shoots flushed. At the same time, baseline field data on shoot phenology were gathered at several sites and compared with shoots at research centres in Green River in northwestern New Brunswick and at Fredericton. These various data then were extrapolated across the province using climatic and topographic information, applying the rationale that topography and related factors interact with climate to trigger the aforementioned spring events

One obvious example of a climate-influenced phonological process is the colour change of maple leaves in autumn. Although each leaf undergoes the same biochemical changes, trees in northern parts of the province generally are affected earlier than are those farther south.

The onset of spruce budworm feeding is another well documented example of a climatically timed process. The budworm occurs throughout much of Canada and the northern United States. It feeds on softwood species, including balsam fir. The budworm population fluctuates from year to year, periodically undergoing major increases such as took place in the Maritimes and eastern Québec during the 1970s and 1980s. The reduced tree growth and increased tree mortality caused by budworm infestations is considered a threat to wood supplies. Thus, much effort has gone into developing tools to monitor the budworm.

A spruce budworm larva feeds on a spruce shoot. *Photograph courtesy of Kees van Frankenhuyzen, Canadian Forest Service.*

The springtime growth spurt of spruce and fir trees is affected by temperature, topography, aspect, day length, and moisture availability; the spring emergence of the budworm is also driven by temperature. Although the budworm's appetite for new foliage is not fully synchronized in each locale with the flushing of young evergreen shoots, both shoot flushing and larval emergence react to similar environmental cues. Data collected over many years were used to generate a spruce budworm emergence map, pictured here. The map helps scientists to coordinate actions such as application of aerial pesticides used to reduce the budworm population.

The average difference between phenological zones with regard to shoot extension and budworm emergence was about two to three days. The difference between the Grand Lake Ecoregion and Highlands Ecoregion averages 2 to 3 weeks.

Conclusion

This overview of the seven New Brunswick ecoregions has considered ecoregions at their broadest, continental scale, outlining the distribution of their tree and understorey species, wetland types, and some animal species. In so doing, it has set the stage for a more detailed look at ecoregions. The next seven chapters describe each ecoregion in detail, offering a closer view of the complex interactions between geology, climate, flora and fauna, wetlands, and human history across the ever-changing landscape we call New Brunswick.

PART II

Portrait of New Brunswick

Ecoregions and Ecodistricts

… where facts and data describing the human and natural history of New Brunswick's ecoregions and ecodistricts are presented …

Introduction to Part II:

Portrait of New Brunswick Ecoregions and Ecodistricts

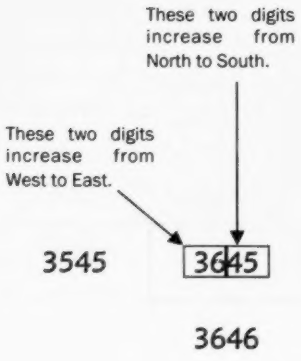
Part I presented background information intended to familiarize the reader with the aims, methods, and concepts of Ecological Land Classification. Part II invites the reader to view parts of the province of New Brunsiwck—the ecoregions and ecodistricts—through an ecological lens.

How to Use the Information presented in Part II

Each of the Chapters from 7 through 13 is focused on one of New Brunswick's seven ecoregions. The first section of each chapter provides an ecoregion overview, which is followed by sections describing in turn each of the ecodistricts that's nested within it.

Finding the right ecoregion or ecodistrict

To determine in what ecoregion or ecodistrict a certain community or location in the Province of New Brunswick is situated, refer to Plate I: Reference Map for New Brunswick Ecoregions and Ecodistricts on page 93. This shaded elevation map will provide you with the name and number of the ecoregion or ecodistrict of interest. Areas of higher elevation are shaded pale green; low elevation areas are shaded dark green. For ease of reference, the names and numbers listed in the table that accompanies the Map are also provided in the top corner of every right-hand page in Part II.


These two digits increase from North to South.
These two digits increase from West to East.
3545
3645
3646

Finding your location on an ecosite map

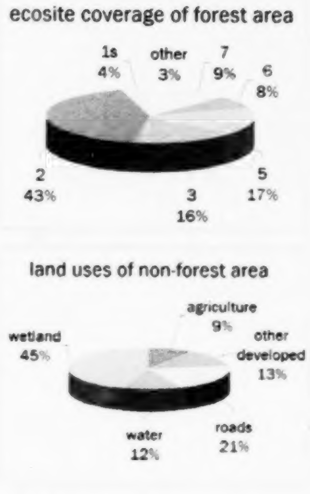
An ecosite map is situated near the end of each ecodistrict description. A map grid that corresponds to the New Brunswick forestry map index overlies each ecosite map. You can use this map grid to identify on the ecosite map the location if you know where you are on the New Brunswick Atlas, 2nd edition (Province of New Brunswick 2002).

The four digit numbers that occupy the grid cells around two sides of each ecosite map may be used to identify the grid cell number of any cell on the map, in the same way this can be done with the numbers appearing around each map of the New Brunswick Atlas. Because the two left digits on the map increase from West to East, and the two right-hand digits increase from North to South, you can calculate the four digit code for an unlabelled, blank grid cell if you know the four digit code of a nearby labeled grid cell.

Interpreting the ecodistrict pie charts

The 'ecosite coverage of forest area' pie chart present the percent coverage of the forested area of the ecodistrict of the various ecosites listed. The 'other' category sums the percent area coverage of ecosites that individually cover less than 2% of the area.

The 'land uses of non-forest area' pie charts present the percent coverage of non-forested area of the land categories listed. The data are taken from the 1997 New Brunswick Forest Inventory.

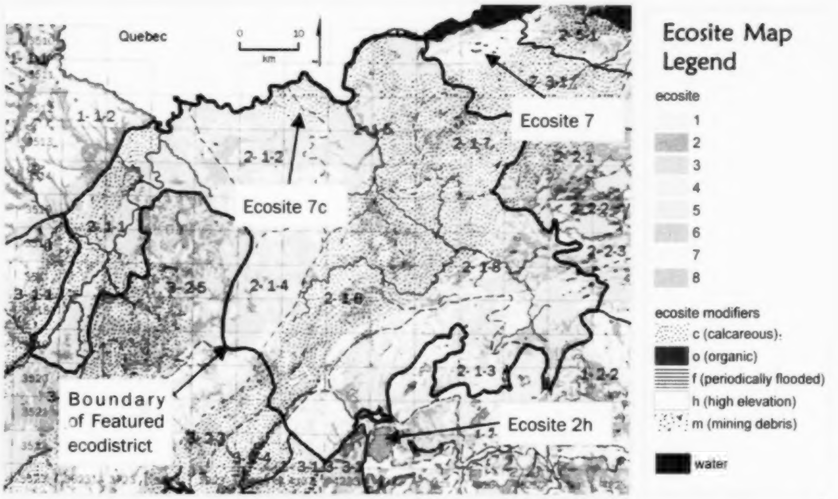


Ecodistrict pie charts.

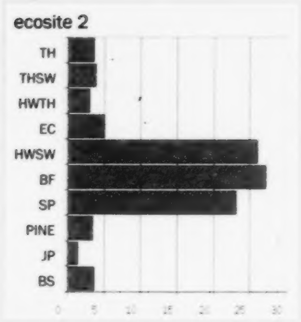
Ecosite maps

The *featured* ecdistrict of an ecosite map is outlined with a solid, heavy, black line. All other ecodistrict and ecoregion boundaries are represented by a lighter solid black line. A dashed line represents ecosection boundaries. The three numbers separated with hyphens that label ecosection polygons provide, left-to-right, ecoregion number, ecodistrict number, and ecosection number. When referring to a specific ecosection, use all three digits to avoid ambiguity; for ecodistricts use the two digits corresponding to ecoregion and ecodistrict (for example, on the map below the featured ecodistrict is Ecodistrict 2-1, the Upsalquitch Ecodistrict).

Colours on the map correspond to the ecosites listed in the legend. Ecosite modifier symbols sometimes overlie the basic ecosite colour symbol. For example, a light yellow polygon overlain with grey stippling represents Ecosite 7c (calcareous). Polygons outlined with a grey border are high elevation polygons. Thus, a dark green polygon outlined in grey represents Ecosite 2h. For a more complete discussion of the ecosite concept, refer to Chapter 5.


Quebec
0
10
km
1-1-2
2-1-2
Ecosite 7c
Ecosite 7
2-5-1
2-1-7
2-2-1
2-1-1
2-2-3
2-1-8
2-1-4
3-2-6
3-1-1
2-1-3
1-2-2
Boundary of Featured ecodistrict
Ecosite 2h
3-1-3
Ecosite Map Legend
ecosite
1
2
3
4
5
6
7
8
ecosite modifiers
c (calcareous)
o (organic)
f (periodically flooded)
h (high elevation)
m (mining debris)
water

A sample ecodistrict map of Ecodistrict 2-1, the Upsalquich Ecodistrict. For an explanation of the labeling, please see the adjacent text.



An ecosite vegetation profile chart. **Vertical axis:** TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis:** percent cover.

Ecosite vegetation profile charts

The percent area coverage of each ecosite has been estimated for each of 10 forest cover classes, and these are presented in the *ecosite vegetation profile* charts that follow each ecosite map. Data are based on the 1997 forest inventory photo interpretation. Data have *not* been adjusted using ground inventory data. By themselves these charts can provide a preliminary suggestion as to what might constitute 'natural' forest cover for Ecosite X in Ecodistrict A. However, ground data verification, and some consideration of the history of land use in the area is recommended before making definitive recommendations. Refer to Chapter 4 for a discussion of land use effects on natural forest cover.

General disclaimer

While every effort has been made to present accurate maps and data, the Department of Natural Resources does not guarantee that the maps and data are correct.

Users of facts presented in this report, as well as the data herein must take care to ensure that applications envisaged for these data are appropriate uses, and that take account of the accuracy of mapped data as well as issues of scale.

The opinions expressed in this document are solely those of the authors and do not necessarily represent the opinion of the Minister of Natural Resources or of the Department of Natural Resources.

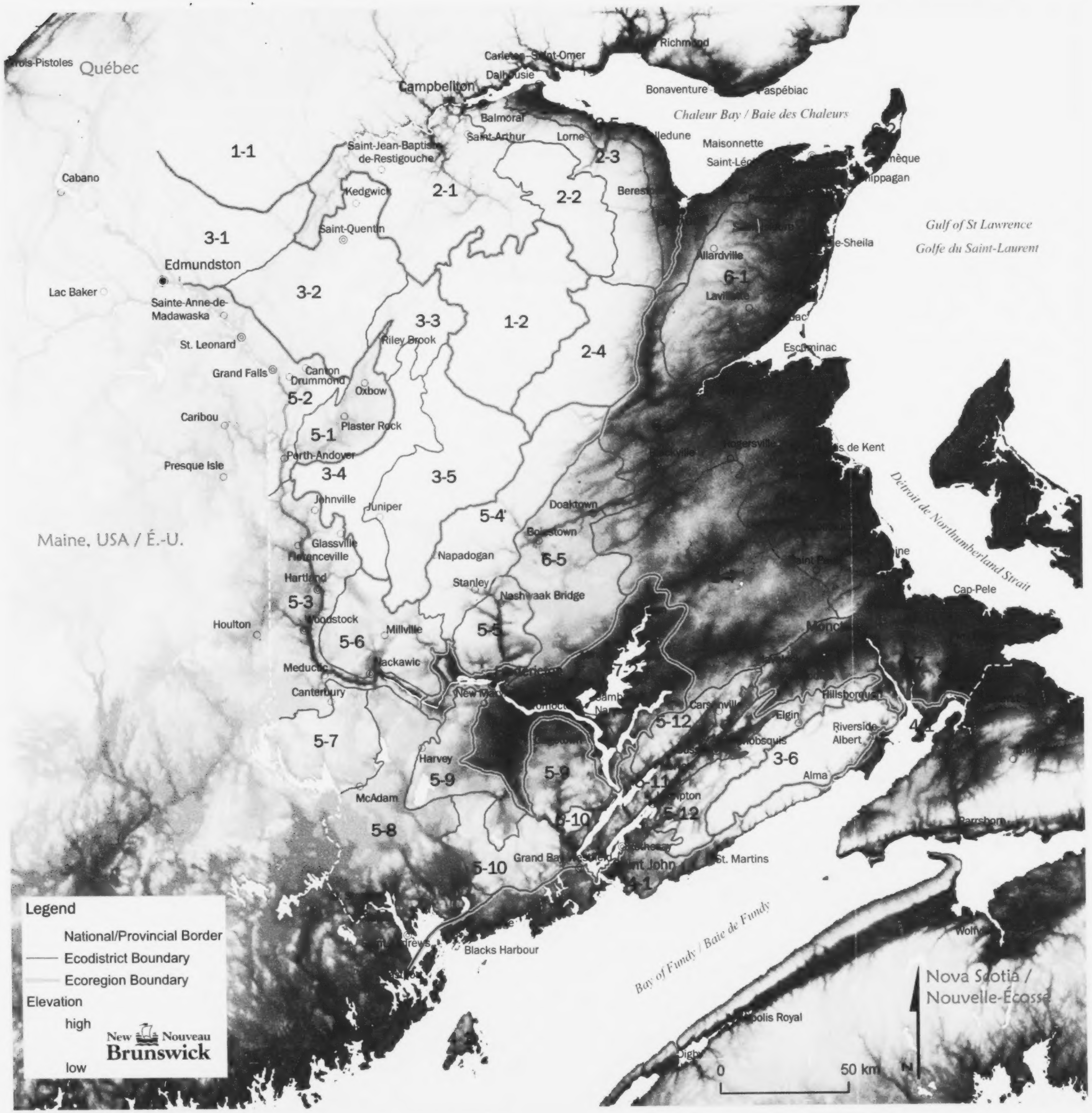

Québec
Trois-Pistoles
Cabano
Lac Baker
Edmundston
Sainte-Anne-de-Madawaska
St. Leonard
Grand Falls
Caribou
Presque Isle
Maine, USA / É.-U.
Houlton
Campbellton
Carleton-Saint-Omer
Dalhousie
Richmond
Bonaventure
Paspébiac
Chaleur Bay / Baie des Chaleurs
Balmoral
Saint-Arthur
Lorne
Belledune
Maisonnette
Saint-Jean-Baptiste-de-Restigouche
Kedgwick
Saint-Quentin
Riley Brook
Canton Drummond
Oxbow
Plaster Rock
Perth-Andover
Johnville
Juniper
Glassville
Florenceville
Hartland
Woodstock
Millville
Nackawic
Meductic
Canterbury
Napadogan
Stanley
Nashwaak Bridge
Doaktown
Boiestown
Harvey
McAdam
Grand Bay-Westfield
Saint John
St. Martins
Blacks Harbour
Alma
Riverside-Albert
Elgin
Hillsborough
Cap-Pele
Escuminac
Allardville
Lavillette
Rogersville
Gulf of St Lawrence
Golfe du Saint-Laurent
Détroit de Northumberland Strait
Bay of Fundy / Baie de Fundy
Nova Scotia / Nouvelle-Écosse
Annapolis Royal
Digby
Parrsboro
Wolfville
1-1
1-2
2-1
2-2
2-3
2-4
3-1
3-2
3-3
3-4
3-5
3-6
4-1
5-1
5-2
5-3
5-4
5-5
5-6
5-7
5-8
5-9
5-10
5-11
5-12
6-1
6-5
0
50 km
N
Legend
National/Provincial Border
Ecodistrict Boundary
Ecoregion Boundary
Elevation
high
low
New Nouveau Brunswick

Plate I: Reference Map for New Brunswick Ecoregions and Ecodistricts

Ecoregion 1: Highlands........................*Chapter 7, p. 91*

Ecodistrict 1-1	Kejwik
Ecodistrict 1-2	Ganong

Ecoregion 2: Northern Uplands...........*Chapter 8, p. 107*

Ecodistrict 2-1	Upsalquitch
Ecodistrict 2-2	Tetagouche
Ecodistrict 2-3	Tjigog
Ecodistrict 2-4	Tomogonops
Ecodistrict 2-5	Nicolas Denys

Ecoregion 3: Central Uplands.............*Chapter 9, p. 141*

Ecodistrict 3-1	Madawaska
Ecodistrict 3-2	Sisson
Ecodistrict 3-3	Serpentine
Ecodistrict 3-4	Brighton
Ecodistrict 3-5	Beadle
Ecodistrict 3-6	Caledonia

Ecoregion 4: Fundy Coast....................*Chapter 10, p. 181*

Ecodistrict 4-1	Fundy Coastal

Ecoregion 5: Valley Lowlands.............*Chapter 11, p. 193*

Ecodistrict 5-1	Wapske
Ecodistrict 5-2	Blue Bell
Ecodistrict 5-3	Meductic
Ecodistrict 5-4	Buttermilk
Ecodistrict 5-5	Cardigan
Ecodistrict 5-6	Nackawic
Ecodistrict 5-7	Cranberry
Ecodistrict 5-8	Magaguadavic
Ecodistrict 5-9	Yoho
Ecodistrict 5-10	Mount Pleasant
Ecodistrict 5-11	Kingston
Ecodistrict 5-12	Anagance

Ecoregion 6: Eastern Lowlands...........*Chapter 12, p. 269*

Ecodistrict 6-1	Tabusintac
Ecodistrict 6-2	Caraquet
Ecodistrict 6-3	Red Bank
Ecodistrict 6-4	Castaway
Ecodistrict 6-5	Bantalor
Ecodistrict 6-6	Kouchibouguac

Ecoregion 7: Grand Lake Lowlands .... *Chapter 13, p. 311*

Ecodistrict 7-1	Aukpaque
Ecodistrict 7-2	Maquapit

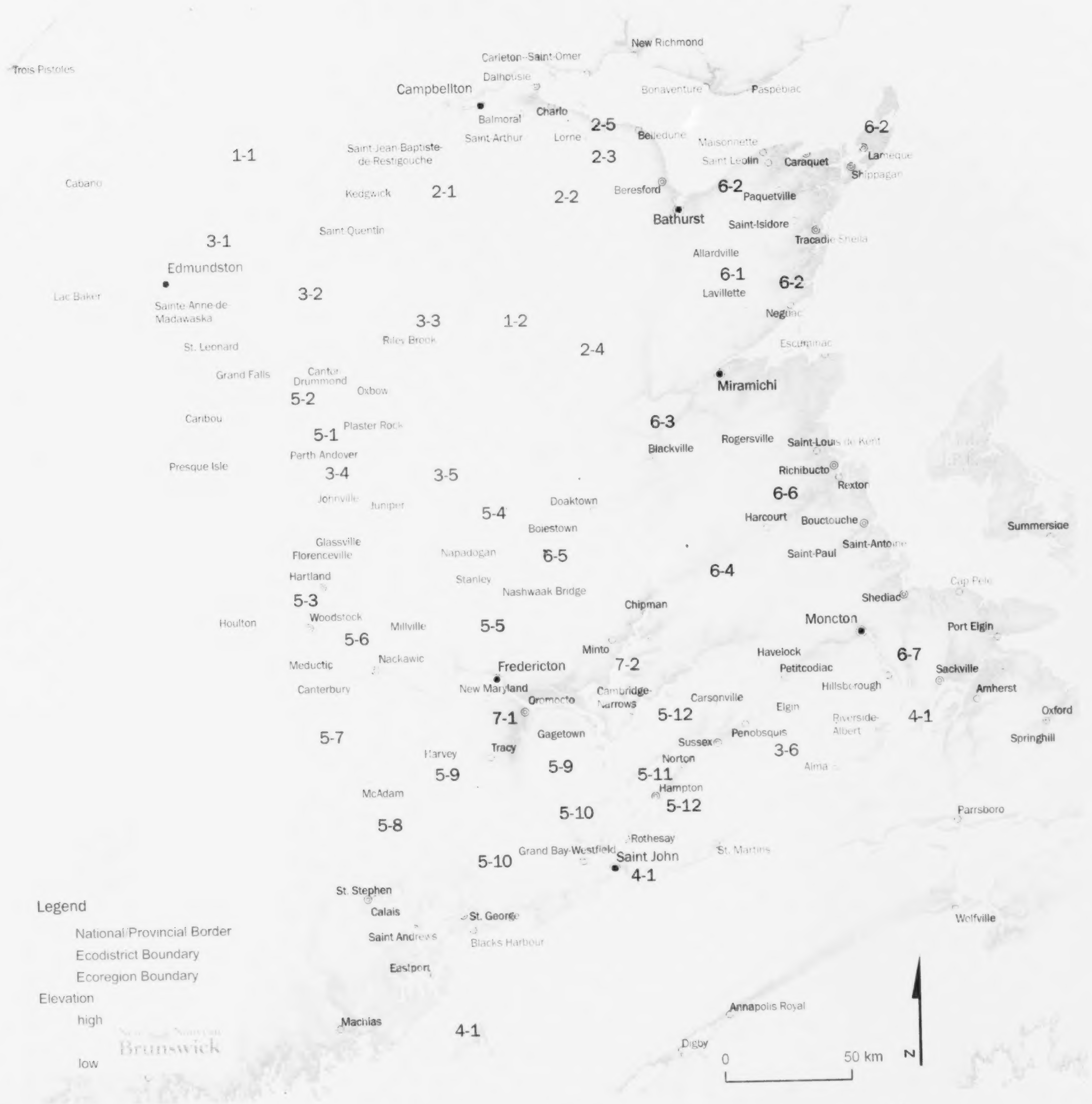

Trois Pistoles
Carleton-Saint-Omer
New Richmond
Dalhousie
Campbellton
Bonaventure
Paspébiac
Balmoral
Charlo
2-5
6-2
Saint-Arthur
Lorne
Belledune
Maisonnette
Lamèque
1-1
Saint-Jean-Baptiste-de-Restigouche
2-3
Saint-Léolin
Caraquet
Shippagan
Cabano
Kedgwick
2-1
2-2
Beresford
6-2
Paquetville
Bathurst
Saint-Isidore
3-1
Saint-Quentin
Tracadie-Sheila
Allardville
Edmundston
6-1
6-2
Lac Baker
3-2
Lavillette
Sainte-Anne-de-Madawaska
Neguac
3-3
1-2
Riley Brook
Escuminac
St. Leonard
2-4
Grand Falls
Canterbury Drummond
Oxbow
Miramichi
5-2
Caribou
5-1
Plaster Rock
6-3
Rogersville
Saint-Louis-de-Kent
Blackville
Perth-Andover
Presque Isle
3-4
3-5
Richibucto
Rexton
Johnville
Juniper
Doaktown
6-6
5-4
Harcourt
Bouctouche
Summerside
Boiestown
Glassville
Saint-Antoine
Florenceville
Napadogan
6-5
Saint-Paul
Hartland
Stanley
6-4
Cap-Pelé
Nashwaak Bridge
Shediac
5-3
Chipman
Woodstock
Moncton
Port Elgin
Houlton
Millville
5-5
5-6
Minto
6-7
Havelock
Nackawic
Sackville
Meductic
Fredericton
7-2
Petitcodiac
Canterbury
New Maryland
Hillsborough
Amherst
Cambridge-Narrows
Oromocto
Carsonville
Oxford
7-1
5-12
Elgin
Riverside-Albert
4-1
5-7
Gagetown
Springhill
Penobsquis
Sussex
Tracy
Harvey
Norton
3-6
5-9
5-9
Alma
5-11
Hampton
McAdam
5-12
5-10
Parrsboro
5-8
Rothesay
Grand Bay-Westfield
Saint John
St. Martins
5-10
4-1
St. Stephen
Legend
Calais
St. George
National/Provincial Border
Wolfville
Saint Andrews
Ecodistrict Boundary
Blacks Harbour
Ecoregion Boundary
Eastport
Elevation
high
Annapolis Royal
Machias
4-1
New Brunswick
Nouveau-Brunswick
Digby
low
0
50 km
N

Plate I: Reference Map for New Brunswick Ecoregions and Ecodistricts

Ecoregion 1: Highlands........................*Chapter 7, p. 91*

Ecodistrict 1-1	Kejwik
Ecodistrict 1-2	Ganong

Ecoregion 2: Northern Uplands...........*Chapter 8, p. 107*

Ecodistrict 2-1	Upsalquitch
Ecodistrict 2-2	Tetagouche
Ecodistrict 2-3	Tjigog
Ecodistrict 2-4	Tomogonops
Ecodistrict 2-5	Nicolas Denys

Ecoregion 3: Central Uplands..............*Chapter 9, p. 141*

Ecodistrict 3-1	Madawaska
Ecodistrict 3-2	Sisson
Ecodistrict 3-3	Serpentine
Ecodistrict 3-4	Brighton
Ecodistrict 3-5	Beadle
Ecodistrict 3-6	Caledonia

Ecoregion 4: Fundy Coast...................*Chapter 10, p. 181*

Ecodistrict 4-1	Fundy Coastal

Ecoregion 5: Valley Lowlands.............*Chapter 11, p. 193*

Ecodistrict 5-1	Wapske
Ecodistrict 5-2	Blue Bell
Ecodistrict 5-3	Meductic
Ecodistrict 5-4	Buttermilk
Ecodistrict 5-5	Cardigan
Ecodistrict 5-6	Nackawic
Ecodistrict 5-7	Cranberry
Ecodistrict 5-8	Magaguadavic
Ecodistrict 5-9	Yoho
Ecodistrict 5-10	Mount Pleasant
Ecodistrict 5-11	Kingston
Ecodistrict 5-12	Anagance

Ecoregion 6: Eastern Lowlands...........*Chapter 12, p. 269*

Ecodistrict 6-1	Tabusintac
Ecodistrict 6-2	Caraquet
Ecodistrict 6-3	Red Bank
Ecodistrict 6-4	Castaway
Ecodistrict 6-5	Bantalor
Ecodistrict 6-6	Kouchibouguac

Ecoregion 7: Grand Lake Lowlands .... *Chapter 13, p. 311*

Ecodistrict 7-1	Aukpaque
Ecodistrict 7-2	Maquapit

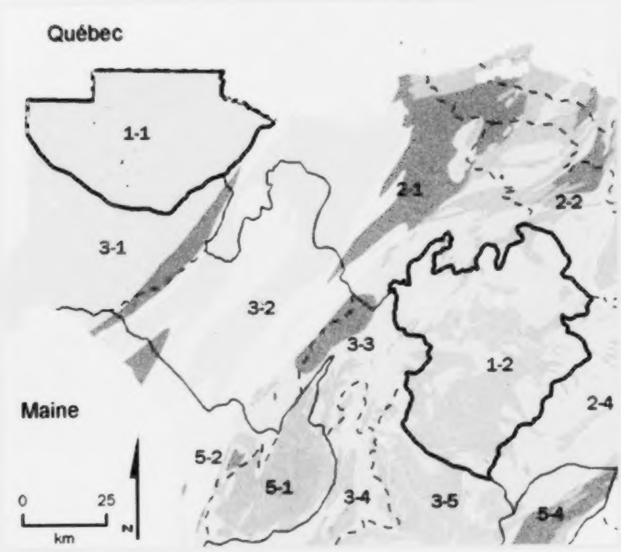
The Highlands Ecoregion is a relatively mountainous area of northern New Brunswick that contains biological elements of the boreal forest .

Chapter 7

1. Highlands Ecoregion

The Highlands Ecoregion consists of two distinct areas of high elevation located in northern New Brunswick. The western portion abuts Quebec and encompasses much of the Kedgwick River watershed. The eastern portion spans the mountainous terrain of north-central New Brunswick including Mount Carleton and the Christmas Mountains.

Separating the two parts of the ecoregion is a zone of lower elevation that takes in parts of the valleys of the Restigouche, Upsalquitch, and Tobique rivers. The forest cover here has strong boreal affinities, due to a climate with shorter, cooler growing seasons, and longer, colder winters than elsewhere in the province. Arctic and subarctic plants cling to the region's windswept summits, while its deep forests resonate in spring with the calls of boreal birds typically associated with more northerly latitudes.



Geology of Highlands Ecoregion

Rock Types

- Highly calcareous sedimentary
- ▨ Calcareous sedimentary
- Non-calcareous sedimentary
- ▨ Early Carboniferous sedimentary
- Late Carboniferous sedimentary
- ▨ Mafic volcanic
- Felsic volcanic
- ▨ Granites and granodiorites

Geology and Landscape

The western portion of the ecoregion is underlain solely by Devonian metasedimentary strata with tight, upright folds, shattered by vertical fractures. The eastern portion contains different lithologies: Ordovician igneous and metasedimentary rocks surrounding a high plateau of Devonian granites. Dissimilar bedrock notwithstanding, both areas have undergone tectonic uplift that has raised their terrain relative to the more southerly parts of New Brunswick. The western ecodistricts have an average elevation of about 500 m. The eastern ecodistricts undulate with mountains surpassing 700 m including Mount Carleton which, at 820 m, is the tallest peak in the Maritimes. The headwaters of several major New Brunswick rivers originate within the region. Tributaries and other feeder streams of the Kedgwick, Gounamitz, Tobique, Miramichi, and Nepisiguit rivers emerge from the higher ground, then run swiftly down through the deeply incised terrain en route to their mother rivers. Elsewhere in the province, rivers and streams tend to move briskly, flow or meander, but here they are more likely to be furious torrents, or have impressive rapids or falls. The region contains few lakes, the mountain-rimmed Nictau and Bathurst lakes in the east, and the emerald Green States Lake in the western section being perhaps the most notable. A small and shallow lake in the far northwestern corner of the province, humbly named Mud Lake, is the only lake in New Brunswick that drains into the St. Lawrence River.

Climate

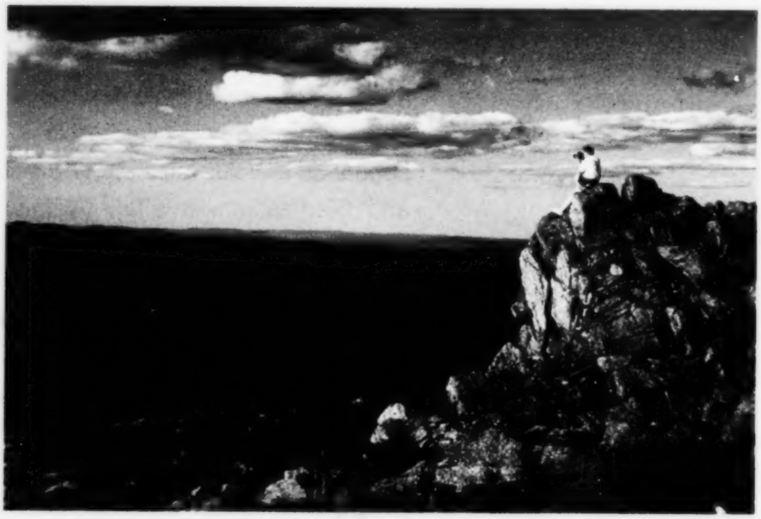
The combination of rough topography and high elevation gives the Highlands Ecoregion a cool, wet climate characterized by mist-wrapped mountains in summer and heavy snowfalls in winter. The region sits at the same latitudes as the warmer, coastal Acadian Peninsula, yet its more elevated terrain has colder temperatures than the coast, ones more typical of a higher latitude. Average annual temperatures here are the lowest in New Brunswick, and the first frost often brushes the mountainsides by early September. The region's abundant precipitation is surpassed only by that of the

Fundy Coast Ecoregion and parts of the Central Uplands Ecoregion. The generous amounts of rain and snow result from orographic lifting, the phenomenon whereby prevailing winds rise over elevated ground, cool, and then release their condensed moisture. Precipitation falls mainly in the western portions of both western and central ecodistricts of the Highlands Ecoregion, leaving a rain shadow to the east. This regional variation in summer rainfall leads to fire-prone conditions in some areas and fire suppression in others. Orographic lifting also creates an unusual pattern of convection currents that, during the summer months, can translate into formidable lightning. The storms produce grand displays that dramatize the mountain peaks and delight sheltered hikers, but they also contribute to the region's high frequency of forest fires.

Forest Cover

The forest cover of the Highlands Ecoregion is dominated by balsam fir, white birch, black spruce, and white spruce, species with northern affinities that reflect the cool, wet climate and harsh winter conditions. Indeed, some scientists regard the area as a small boreal outlier, isolated from the extensive boreal forest that stretches from Newfoundland to the Yukon. Traversing the ecoregion from its lower elevations up to its summits is roughly equivalent to shifting several degrees northward in latitude, with the accompanying gradation in forest composition. The exposed mountaintops with shallow soils, where they show trees at all, display boreal-type forest stands of nearly pure black spruce or balsam fir. These species require fewer nutrients and morphologically are well adapted to heavy snowfalls and strong winds. White birch and white pine appear in the more protected, well drained sites farther downslope, and yellow birch becomes more frequent at lower elevations. Rocky, gravelly soils favour mixtures of black spruce, jack pine, and white pine, whereas the more fertile soils support balsam fir with some white spruce, yellow birch, and

Mount Carleton Park, Highlands Ecoregion.



Mountain ash is usually a large shrub but in the Highlands Ecoregion it often grows to occupy the forest canopy. *Photograph courtesy of the New Brunswick Museum.*

mountain ash. The last-named species achieves an unusually large size in this area of the province, perhaps in part because white tailed deer are relatively scarce here. The transition to other ecoregions occurs at lower elevations. Here, sugar maple, red spruce, and beech begin to appear alongside the yellow birch, fir and spruce. Cedar, white elm, balsam poplar, and black ash occasionally occur, but species with more southerly ranges – ironwood, hemlock and butternut, for instance – are notably absent.

Because the eastern parts of the ecoregion lie in rain shadows and undergo regular lightning strikes, fire disturbance has been a determinative factor in forest composition. Fire-adapted species such as jack pine and trembling aspen are concentrated in the Nepisiguit River valley; jack pine also occurs at other locales in scattered patches. The western section, by contrast, receives abundant precipitation that helps to reduce the frequency of fires; it therefore has few jack pine and aspen. Regional understorey species mirror the northern affinities of the canopy. The less fertile soils over granitic bedrock support such boreal indicator plants as bunchberry, Schreber's moss, plume moss, wild lily-of-the-valley, wintergreen, sheep-laurel, and blueberry. The more fertile soils associated with sedimentary terrain might support a higher diversity among the understorey dominants, including mountain wood fern, common wood-sorrel, and other sub-boreal species. Several rare subarctic plants also occur in this region (see Kejwik and Ganong ecodistricts).

Wetlands

The ecoregion's rugged terrain leaves little room for wetland formation. Only limited areas suitable for wetlands can be found along its fast-flowing rivers and steep-sloped lakes. The most common wetland type is streamside shrub swamps that usually are dominated by alder. In addition, peatlands have developed in ancient glacial drainage channels or in scattered small depressions. Preliminary investigations of these peatlands indicate that they typically have an abundant cover of shrub and dwarf trees, with a low diversity of sphagnum moss species. Beaver activity has added to the number and diversity of wetlands in this, as well as most ecoregions in New Brunswick. Meadows have formed over some sites formerly occupied by beaver ponds. The meadows display an array of graceful sedges and grasses, plus shrubs associated with acidic conditions: leather-leaf and Labrador tea, for instance. The more calcareous sites may harbour some of the less common sedges such as lake sedge or hidden-scale sedge.

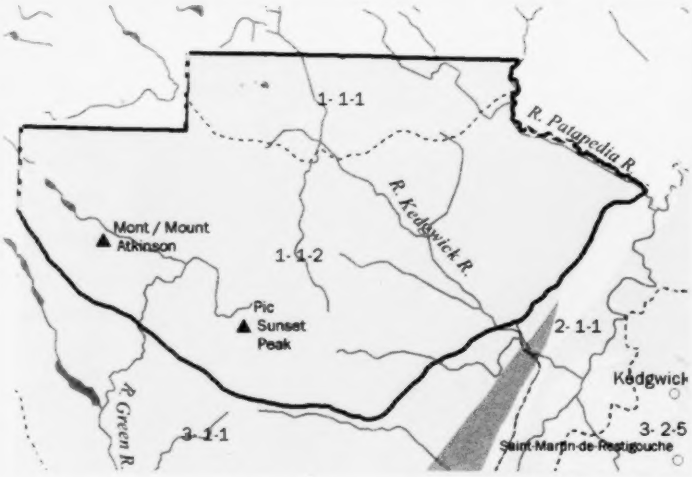
1.1. Kejwik Ecodistrict

The Kejwik Ecodistrict is a visually dramatic area in the northwest extremity of New Brunswick adjoining the Gaspé area of Québec. It is one of two ecodistricts within the Highlands Ecoregion.

Geology

The bedrock is composed solely of Devonian metasedimentary strata belonging to the Temiscouata Formation. They consist mainly of siltstone and slate, with some sandstone and greywacke along the northern reaches of Green River and its tributaries.

Rocks in the area have been compressed into tight upright folds with many vertical fractures so that outcrops typically appear shattered. The terrain displays a regional pattern of faults and other lineaments that subsequently influenced the flow direction of waterways and glacial ice.



Geology of Kejwik Ecodistrict

Rock Types

Highly calcareous sedimentary

Calcareous sedimentary

Non-calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites

The most recent glacial event occurred between about 2.5 million and 11,000 years ago. It produced massive ice sheets that scoured existing river valleys such as those of the Kedgwick and Green rivers, rounding hilltops and transporting unconsolidated sediment. Soils in the ecodistrict owe much to the sand, silt, clay, and rock fragments deposited by retreating glaciers.

Landscape and Climate

The Kejwik Ecodistrict presents a stunning landscape of tumultuous rivers and steep-sided valleys. Waterways have eroded and incised the bedrock into ridges, slopes, and canyons. Two of the three main rivers – the Kedgwick and Gounamitz – drain the east and north portions of the ecodistrict into the Restigouche River. The third river, the Green, originates near Wild Goose Lake then turns southeast to drain into theSaint John River.

Maps of this ecodistrict display colourful names such as Six Mile Gulch and Devil's Elbow Rapids. The old supply camp of Rapids Depot on Kedgwick River speaks to one of a string of rapids that interrupt the river along its noisy passage down from the Gaspé.

The many bedrock fractures and fissures provide natural pathways for streams and rivers. Conversely, the combination of porous rock structure and rugged landscape effectively has precluded the accumulation of large bodies of water. The ecodistrict as a result has very few lakes, none longer than 3 km, the most noteworthy being States Lake and Wild Goose Lake. Relief is moderate in the western portion of the district, and tends to be steeper and visually more dramatic in the eastern part , in the valley of the Kedgwick River.

With elevations ranging from 200 m at Kedgwick River to 600 m on the ridges, the average elevation of this ecodistrict is a fairly high 500 m, which results in cool temperatures and abundant rainfall.

The Kedgwick River Valley is flanked by forests of white pine, black spruce and balsam fir. *NBDNR photo.*

Soils

Soils in the Kejwik Ecodistrict are moderately fertile, as the bedrock of metasedimentary slate, siltstone and metaquartzite weathers slowly to yield moderately acidic soil. Locally, rocks and transported glacial till are calcareous, and soil pH may approach neutral values. Soils are derived from a variety of glacial deposits plus pre-glacial residual material. Textures range from loamy to gravelly.

The ridgetops are covered primarily by weathered, *in situ* rock fragments and soil of the stony, loamy Glassville Unit. Non-compact, gravelly and sandy loams of the McGee Unit blanket the more protected hillsides. Compact, sandy loams and loams of the Holmesville Unit are associated with well drained areas of lower relief such as north of States Lake. The coarse-textured Grand Falls Unit was formed from glaciofluvial gravel and occurs near Mud Lake and on upper reaches of McDougall Brook. In areas of the northeast, natural processes have led to development of soils with cemented iron pans at a depth of 20 to 30 cm. These limit tree rooting and appear to negatively affect productivity for forestry.

Biota

The Kejwik Ecodistrict displays a range of ecosites typical of a cool moist climate with high relief.

Balsam fir dominates the forest at all locales. The acidic upper slopes and ridgetops (5h and 7) tend to support a mixed forest of balsam fir with white birch, red maple and yellow birch as the dominant hardwoods. American mountain-ash is more common here than elsewhere, and occasionally reaches tree-size proportions, surpassing its more typical bush aspect.

The lower plateaus and warmer mid-slopes (5) are covered with balsam fir accompanied by white spruce or red spruce; red spruce grows preferentially on more protected aspects such as along tributaries of the Kedgwick River. At even lower elevations (2), black spruce with some white pine is fairly common in areas of frequent fire disturbance such as north of States Lake. Black spruce and white pine also tend to occur on sites underlain by dry soils of the Grand Falls Unit.

The South Kedgwick River Black Spruce Ecological Reserve is situated just northeast of Summit Depot on an upland area of rolling hills. This site supports an outstanding example of an upland black spruce stand, and federal government scientists intensively studied it during the 1960s. Summit Depot, in the western portion of the district, was a hub of scientific activity in the 1950s and 1960s as federal scientists studied the effects of a spruce budworm outbreak on the fir-dominated forest.

Fox sparrows can be found nesting in coniferous forests of this ecodistrict. The eastern population approaches the southern limit of its breeding range here, in northern New Brunswick.

Stands with a greater proportion of yellow birch and sugar maple appear at the ecodistrict's southern fringes, but beech, like most species with southern affinties, is very uncommon throughout the area. Post-harvest stands are often dominated by balsam fir, white birch, and pin cherry, with an understorey of balsam fir.

The Kejwik Ecodistrict contains an interesting assemblage of unusual or rare flora and fauna, some with boreal associations. A bedstraw commonly known as northern wild licorice occurs at Summit Depot, as does the small round-leaved orchis and a very rare sedge, the closed-head sedge. Just north of Summit Depot is Wild Goose Lake, which has an unusually high pH of 9.5.

The rare aquatic plant awlwort grows in the shallows of States Lake. States Lake at 50 m is the deepest lake in the province and also is one of only twelve provincial lakes with a self-sustaining lake trout population. Lake trout is a species typical of cold waters.

Settlement and Land Use

This ecodistrict lies within the traditional Mi'kmaq territory of Gespegeoag. Coastal people from the former village of Tjigog (located outside the ecodistrict at Atholville) visited Kejwik Ecodistrict regularly for hunting and fishing, and also used it for overland travel to the Saint John River valley. The Mi'kmaq name of *madawamkejwik*, given to the *'river that likes to flow underground'*, has transformed over time into Kedgwick River.

Clyde Hynes, the Kedgwick Bard, ca. 1920. *Photograph courtesy of the Harriet Irving Library Archives.*

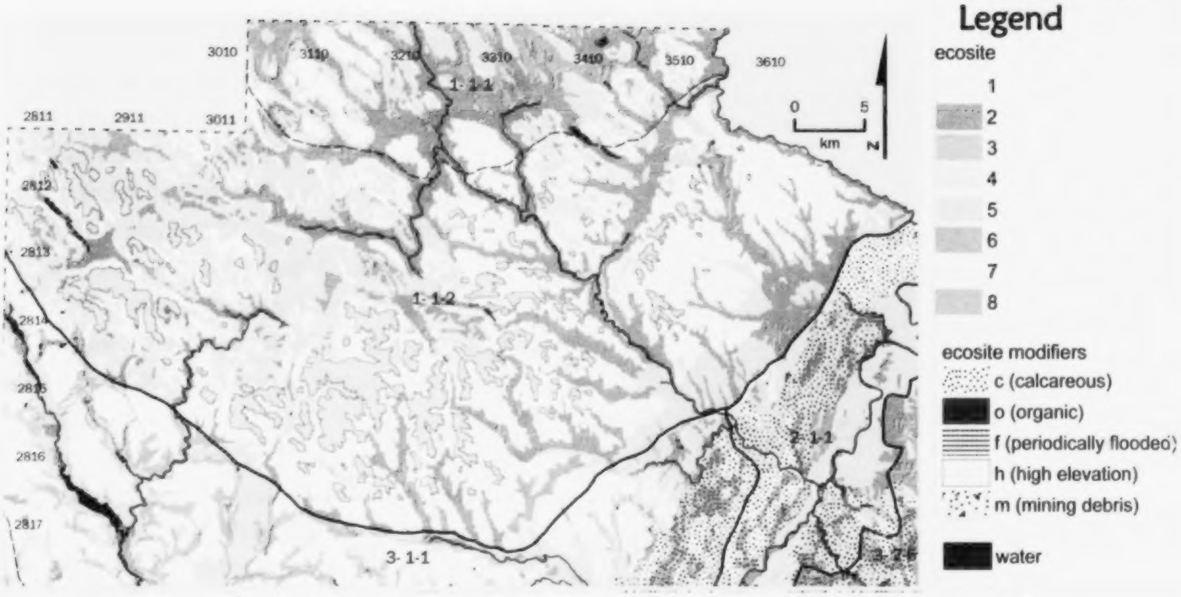
Europeans visited the area by at least the 1500s, but for the next few centuries concentrated more on its rich fur and fish resources than its magnificent stands of pine and spruce. When the Miramichi Fires of 1825 devastated timber throughout much of central New Brunswick, New Brunswick lumber barons cast their eyes northward.

Within four decades, timber crews had exhausted the largest stands of mast pine along the Restigouche and its tributaries and had begun to remove saw logs. The 1875 completion of the Intercolonial Railway through the ecodistrict gave further impetus to logging and other economic ventures.

Several lumber companies were active here during the 1920s. Rapids Depot on Kedgwick River served as a halfway station, storing supplies brought up from Restigouche River before they were shipped further inland. The depot's most famous caretaker was Clyde Hynes, known as the Kedgwick Bard for his poems and stories.

1.1. Kejwik Ecodistrict at a Glance

Ecoregion: Highlands
Area: 208, 689 ha
Average elevation above sea level: 416 m
Average May-September precipitation: >500 mm
Average annual degree-days above 5°C: 1300–1400

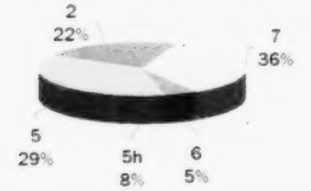


Ecosite Map Legend

ecosite
1
2
3
4
5
6
7
8
ecosite modifiers
c (calcareous)
o (organic)
f (periodically flooded)
h (high elevation)
m (mining debris)
water
0
5
km
N
3010
3110
3210
3310
3410
3510
3610
2811
2911
3011
2812
2813
2814
2815
2816
2817
1-1-1
1-1-2
2-1-1
3-1-1
3-2-6

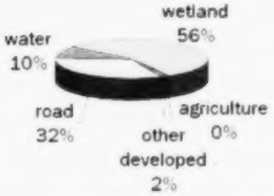
97% of Kejwik Ecodistrict has forest cover

ecosite coverage of forest area

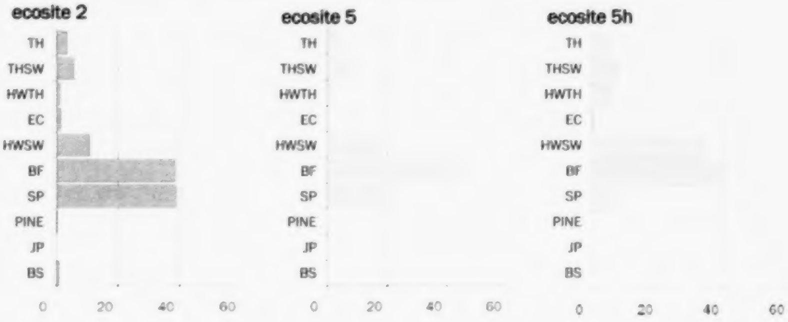


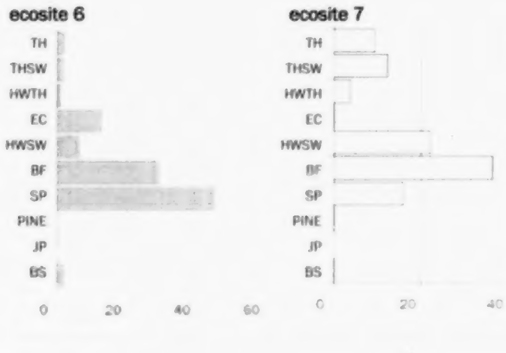
3% of Kejwik Ecodistrict is not forested

principal land uses of non-forest area



Percent cover of forest stand types by ecosite

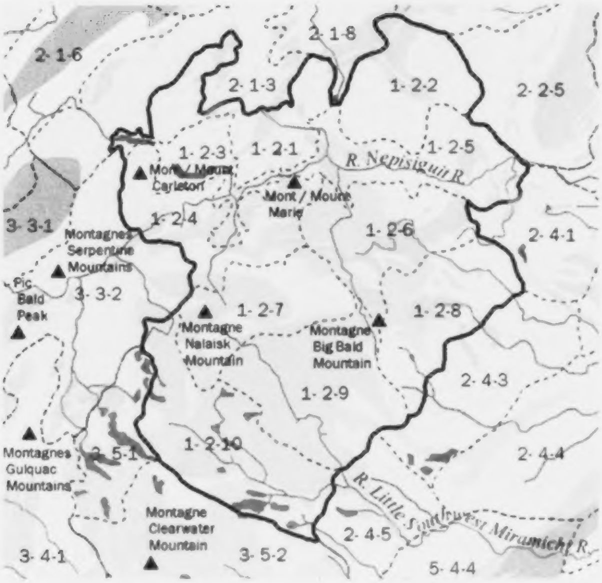




Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.

1.2. Ganong Ecodistrict

The Ganong Ecodistrict lies in north-central New Brunswick encircled by the lower terrain of the Southern and Northern Uplands. It is one of two ecodistricts within the Highlands Ecoregion and has truly boreal affinities.


2-1-6
2-1-8
2-1-3
1-2-2
2-2-5
1-2-3
1-2-1
1-2-5
R. Nepisiguit R.
Mont / Mount Carleton
Mont / Mount Marie
3-3-1
1-2-4
1-2-6
2-4-1
Montagnes Serpentine Mountains
Pic Bald Peak
3-3-2
1-2-7
1-2-8
Montagne Nalaisk Mountain
Montagne Big Bald Mountain
2-4-3
1-2-9
Montagnes Gulquac Mountains
3-5-1
1-2-10
2-4-4
R. Little Southwest Miramichi R.
Montagne Clearwater Mountain
2-4-5
3-4-1
3-5-2
5-4-4

Geology of Ganong Ecodistrict

Rock Types

- Highly calcareous sedimentary
- Calcareous sedimentary
- Non-calcareous sedimentary
- Early Carboniferous sedimentary
- Late Carboniferous sedimentary
- Mafic volcanic
- Felsic volcanic
- Granites and granodiorites

Geology

The bedrock in Ganong Ecodistrict consists primarily of Ordovician volcanic, metasedimentary and granitic rock, all of which have been intruded or overlain by several types of Devonian rocks.

The Naturalists Range in the northeast corner is formed mainly of Ordovician volcanic rocks. Mount Carleton and Sagamook Mountain in the northwest are underlain by Devonian felsic volcanics and metasedimentary rocks. Mount Elizabeth, Big Bald Mountain, and Christmas Mountains lie further south and are located within plutons of Devonian granites and related rocks. The names of mountains in the Naturalists Range acknowledge some early New Brunswickers such as William Francis Ganong, Moses Perley and Montague Chamberlain who laid the groundwork for much of our present scientific knowledge of the province.

On January 9, 1982 an earthquake measuring 5.7 on the Richter scale shook New Brunswick. Its epicentre lay within the granite pluton containing the Christmas Mountains and Big Bald Mountain.

During early stages of deglaciation, the summits in and around Mount Carleton began to protrude above the thinning ice. Exposure caused the rocks to undergo intense frost shattering, resulting in the formation of angular bedrock projections called tors. Tors remain visible on most higher peaks in the area.

Landscape and Climate

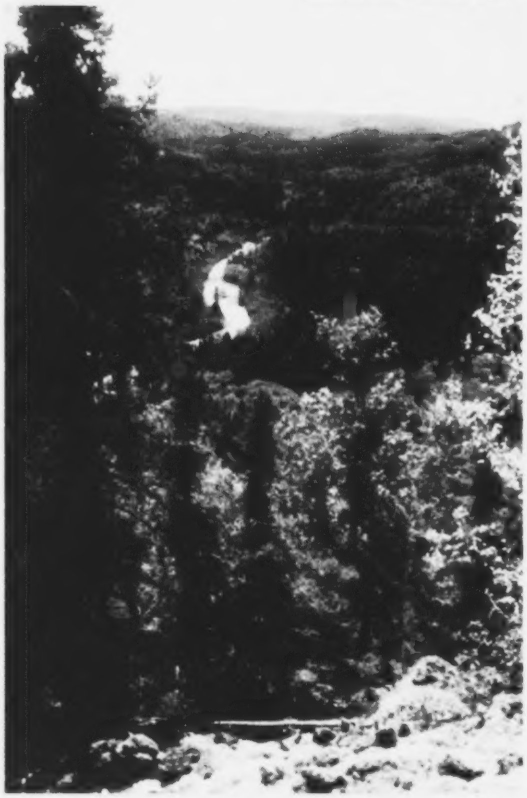
The rocks here translate into three broad divisions within the landscape: a northern mountainous terrain of felsic volcanic and metasedimentary rocks; a high central plateau of granites and related rocks; and a southern granitic area with a more gently rolling topography.

Mount Carleton at 820 m is the tallest peak in the Maritimes. Mount Carleton and Sagamook Mountain lie in the northern division, where elevations commonly exceed 600 meters. Together they create the divide of two river systems, as Nictau Lake drains west via the Tobique River into the Saint John River, and Nepisiguit Lake drains east via the Nepisiguit River into Chaleur Bay.

Nepisiguit River and its tributaries roughly delineate the border between the north and central divisions. The river rises in the northwest corner of the ecodistrict and drains from west to east, incising the mountainous terrain deeply into a patchwork of slopes and canyons. In some locales, such as Mount Marie near Popple Depot, the river gorge drops 400 m from peak to riverbed.

The average elevation remains around 750 m in the central granitic plateau, then gradually drops below 500 m as one moves southward into a landscape of rounded hills and broad valleys. The southern area contains noticeably more lakes, a reflection in part of its gentler terrain.

The extreme elevations and resultant cold, wet climate give this ecodistrict the lowest annual average temperatures in New Brunswick. As well, its average summer precipitation is exceeded provincially only by that in the Fundy Coast Ecoregion.



The view from Mt. Marie, looking west, shows the Nepisiguit river below and, in the distance, the igneous bedrock massif that includes Mt. Carleton, Mt. Sagamook, and other high points within Mt. Carleton Provincial Park. *DNR photo.*

Soils

The range of soil texture and fertility mirrors the variation in bedrock and glacial history.

The felsic volcanic rocks in the north weather very slowly and give rise to coarse-textured, poor soils, except where they are accompanied by metasedimentary rocks which contribute fine-textured particles. Least fertile are the gravelly, loamy sands of the Gagetown Unit that line the Nepisiguit River valley. Shallow, stony loams and sandy loams of the Lomond Unit blanket the felsic volcanic summits, whereas deeper, compact loams of the Popple Depot Unit are associated more with middle and lower slopes. Both Popple Depot and Lomond soils have low inherent fertility.

The central plateau contains granites, granodiorites, and related rocks. Such soils can be moderately productive sites for timber if they are medium textured, but units in this area generally are coarse textured and have low productivity. The Big Bald Mountain Unit, for instance, derives from *in situ* weathering of granitic rocks, contains a high proportion of coarse rock fragments, and is found on hill crests and upper slopes where outcrops are common.

Soils in the south can be somewhat richer. The most fertile units are loamy Britt Brook Unit soils derived from a mixture of granitic and metasedimentary rock types. The Juniper Unit also is common in the south, but its non-compact, bouldery-to-gravelly loamy sands are too coarse for high forest productivity.

Biota

Balsam fir and black spruce dominate the forest here, but their relative prominence and accompanying tree species shift from north to south. Balsam fir prevails in the northern terrain. White birch appears as a post-fire, early successional species near Mount Carleton, specifically on shallow soils covering strong slopes (4). Trembling aspen is limited mainly to roadsides and to low elevations in the Nepisiguit River valley. Beech is absent here and throughout the ecodistrict. The high plateau of the central terrain is blanketed by a nearly pure cover of balsam fir (5h). In November of 1994, approximately 17,000 ha of this forest was blown down in a windstorm. The more nutrient-enriched mid-slopes (5) support balsam fir accompanied by white spruce and red spruce, white birch and yellow birch, red maple, and American mountain ash.

In the southern division, balsam fir prevails in sites with moist soil (2), but black spruce becomes more dominant on dry granitic soils (1). The granitic summit and talus slopes of Mount Elizabeth, for instance, are covered by a representative black spruce forest, which is now designated as the Mount Elizabeth Ecological Reserve. On warmer sites at lower elevations (7), mixed stands of sugar maple and yellow birch become more prominent. However, sites supporting pure sugar maple stands are rare.

Forests underlain by the Gagetown Unit along the Nepisiguit River have experienced high fire frequency, which favours the propagation of jack pine. Jack pine dominates in these areas of dry, coarse-textured soils that line steep river valleys, and in places it forms pure stands. The Nepisiguit River valley also displays patchy, scattered stands of white pine that could represent remnants of earlier extensive tracts. Red pine is even less common overall, but is present locally on a peninsula jutting into Bathurst Lake in Mount Carleton Park.

The Freeze Lakes Protected Natural Area embraces an undisturbed, densely canopied balsam fir stand with little undergrowth except for mosses.

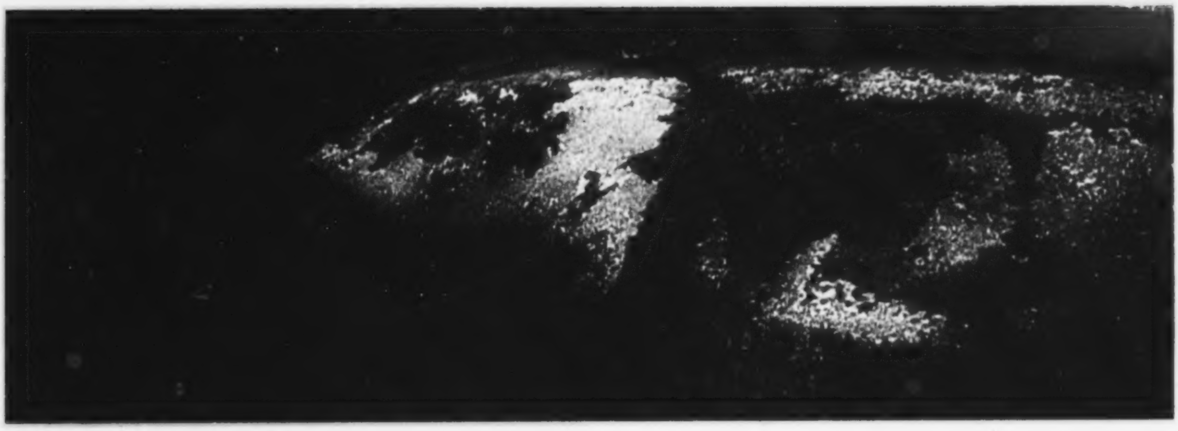
The Ganong Ecodistrict displays boreal and subarctic elements that yield an unusual assemblage of flora and fauna. A very lucky (and careful) day's walk across Big Bald Mountain could reveal sightings of some extremely rare sub-arctic plants: the highland rush and dwarf birch. Mount Carleton Park also possesses several species that thrive on alpine slopes or shaded mossy rocks – plants such as Bigelow's sedge and the tiny mingan moonwort. Mount Denys is one of only a very small number of known sites in New Brunswick for the alpine bilberry.

Despite its rarity elsewhere in New Brunswick, the Gaspé shrew has made its home on both Mount Carleton and Sagamook Mountain. The Gaspé shrew is one of only four mammals found only in Canada and nowhere else (the other two are the Vancouver Island marmot, the Labrador collared lemming, and the Maritime shrew). Another significant species in this ecodistrict is the Bicknell's thrush, a rare bird that typically nests in dense conifer or, occasionally, mixed-wood stands at cool, high-elevation sites. Prior to 1996, the species was considered an isolated population of the more common grey-cheecked thrush. It is now considered considered vulnerable by the committee on the status of endangered wildlife in Canada (COSEWIC). Summer visitors also may be fortunate enough to spot the purple lesser fritillary butterfly.

This patch of older Balsam fir forest was blown down in the November 1994 windstorm that levelled 17,000 hectares of similar forest, triggering a huge wood salvage effort by the New Brunswick forest Industry. *DNR photo*

Settlement and Land Use

The Ganong Ecodistrict straddles traditional territories of the Maliseet and Mi'kmaq people, and aboriginals have frequented the area for at least 2500 years. Its rivers provided salmon, served as a route into the highland interior for hunting game, and facilitated



Serpentine Mountain, Ganong Ecodistrict.

traveling overland via portages between the Saint John and Restigouche rivers.

The Mi'kmaq name of winpegijooik was given to the '*river that dashes roughly along*' and over time has been substantially altered into Nepisiguit River.

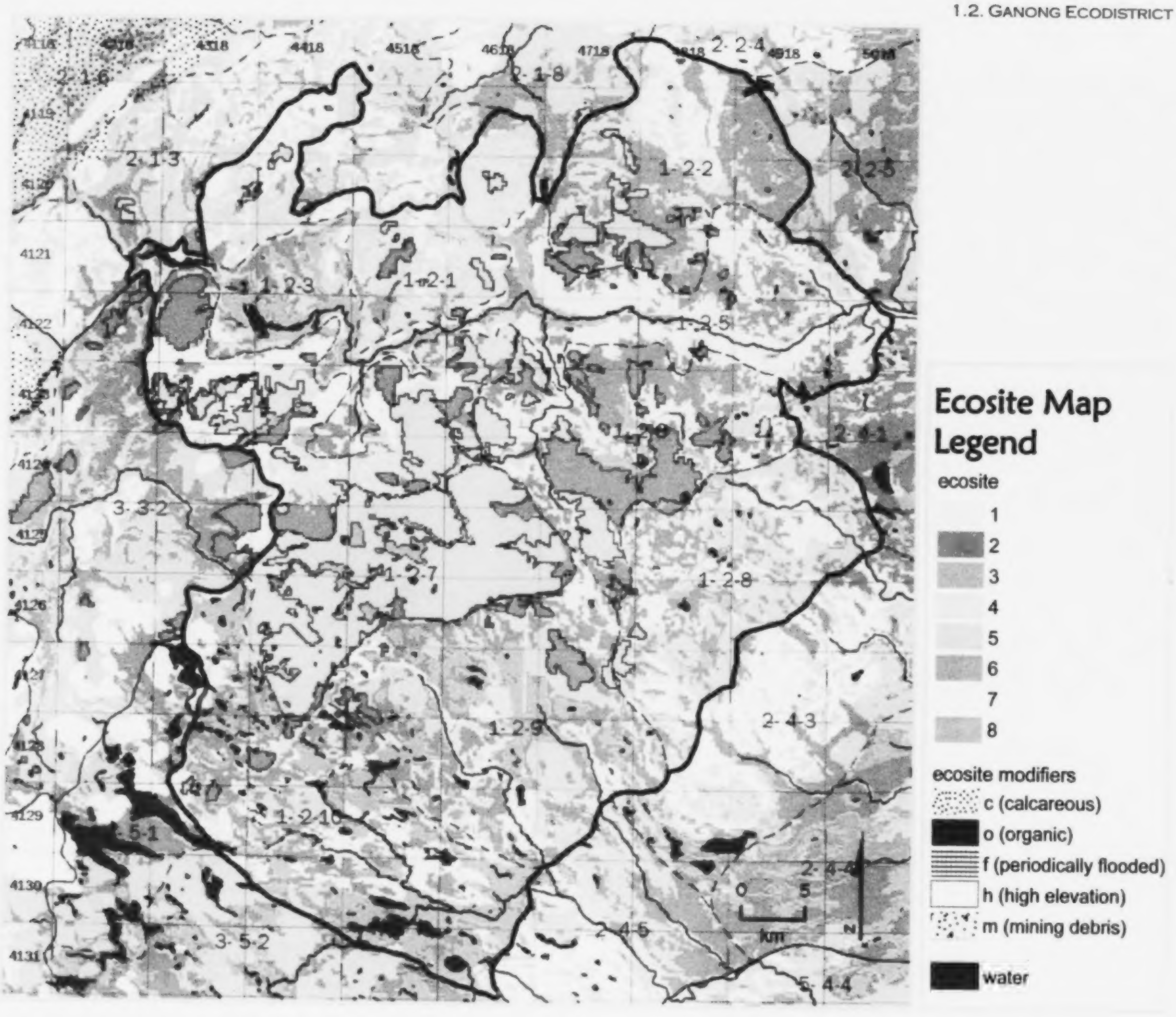
European immigrants likely viewed the terrain of Ganong Ecodistrict with little enthusiasm as it was difficult to reach, inhospitable and effectively non-arable. The only settlements were lumbering camps erected to accommodate itinerant loggers.

Commercial lumbering began in the early 1800s along the most accessible river valleys, concentrating on the Nepisiguit and Northwest Miramichi. A number of base-metal and gold deposits have been discovered over the last century or so, some of which were developed.

The mountainous landscape with its distinctive flora and fauna has attracted naturalists from the early 19th century to the present day. The New Brunswick government created Mount Carleton Provincial Park in 1970 to recognize the ecodistrict's scientific and aesthetic significance, a commitment that has led to an increasing nuber of visiting hikers and naturalists.

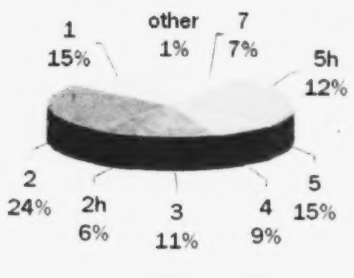
1.2. Ganong Ecodistrict at a Glance

Ecoregion: Highlands
Area: 282, 178 ha
Forest area: 95% of total
Average elevation above sea level: 473 m
Average May–September precipitation: > 500 mm
Average annual degree-days above 5°C: < 1300


Ecosite Map Legend
ecosite
1
2
3
4
5
6
7
8
ecosite modifiers
c (calcareous)
o (organic)
f (periodically flooded)
h (high elevation)
m (mining debris)
water
2-1-6
2-1-3
2-1-8
2-2-4
1-2-2
2-2-5
1-2-3
1-2-1
1-2-5
1-2-6
2-4-1
3-3-2
1-2-7
1-2-8
1-2-9
2-4-3
1-2-10
3-5-1
2-4-4
2-4-5
3-5-2
5-4-4
0
5
km
N
4118
4218
4318
4418
4518
4618
4718
4818
4918
5018
4119
4120
4121
4122
4123
4124
4125
4126
4127
4128
4129
4130
4131

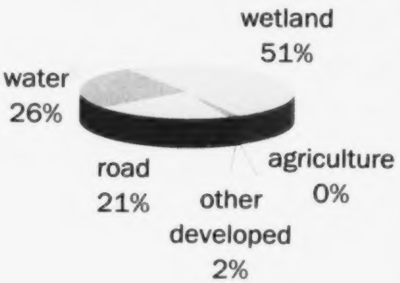
95% of Ganong Ecodistrict has forest cover

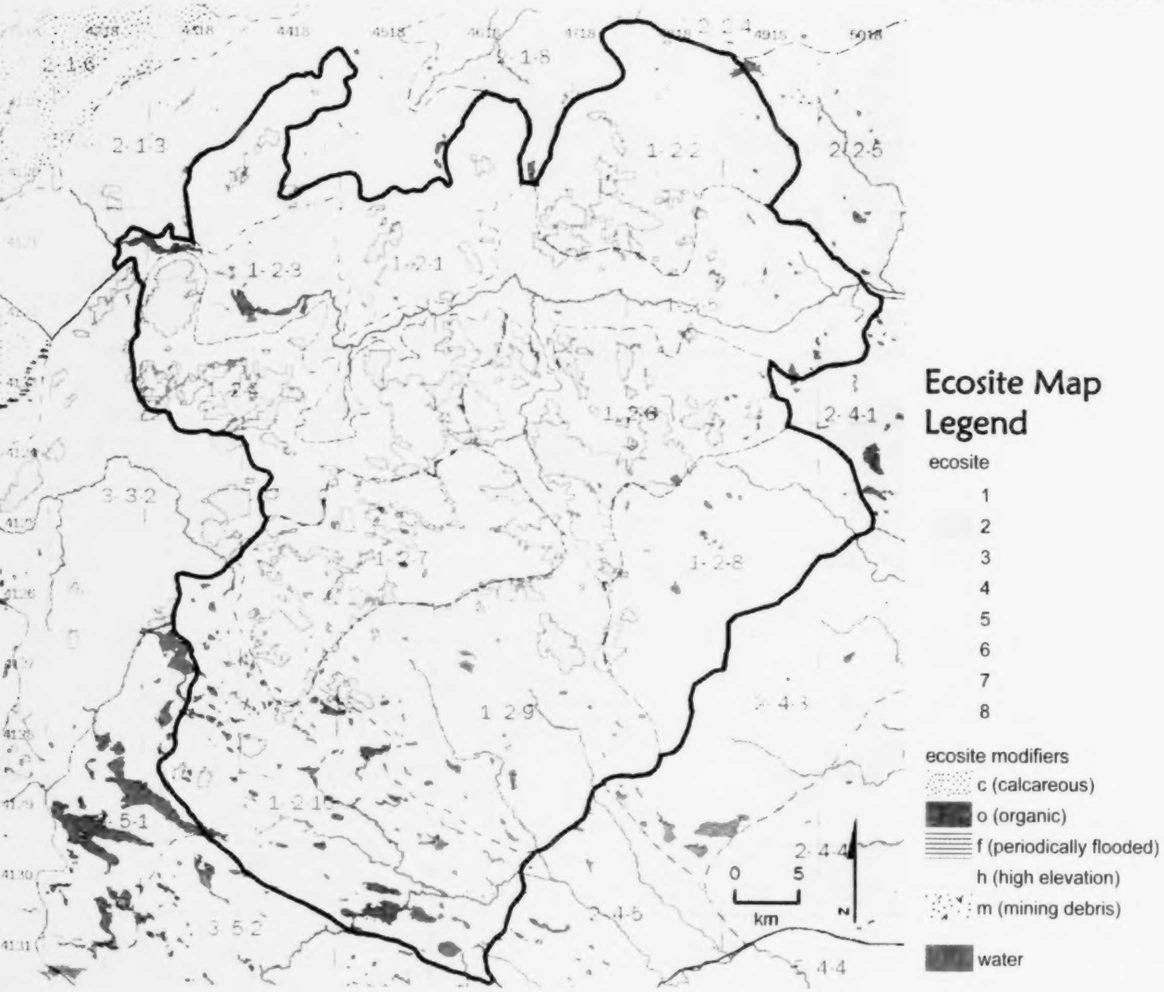
ecosite coverage of forest area



5% of Ganong Ecodistrict is not forested

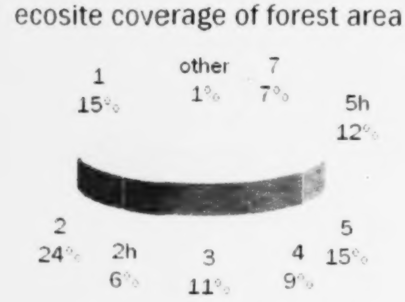
principal land uses of non-forest area

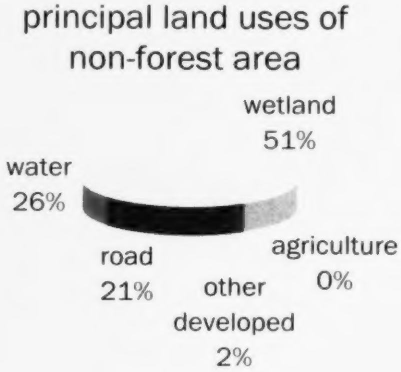



2-1-6
2-1-3
1-8
1-2-2
2-2-5
1-2-3
1-2-1
1-2-5
1-2-6
2-4-1
3-3-2
1-2-7
1-2-8
1-2-9
2-4-3
1-2-10
5-1
3-5-2
2-4-5
2-4-4
0
5
km
N
Ecosite Map Legend
ecosite
1
2
3
4
5
6
7
8
ecosite modifiers
c (calcareous)
o (organic)
f (periodically flooded)
h (high elevation)
m (mining debris)
water

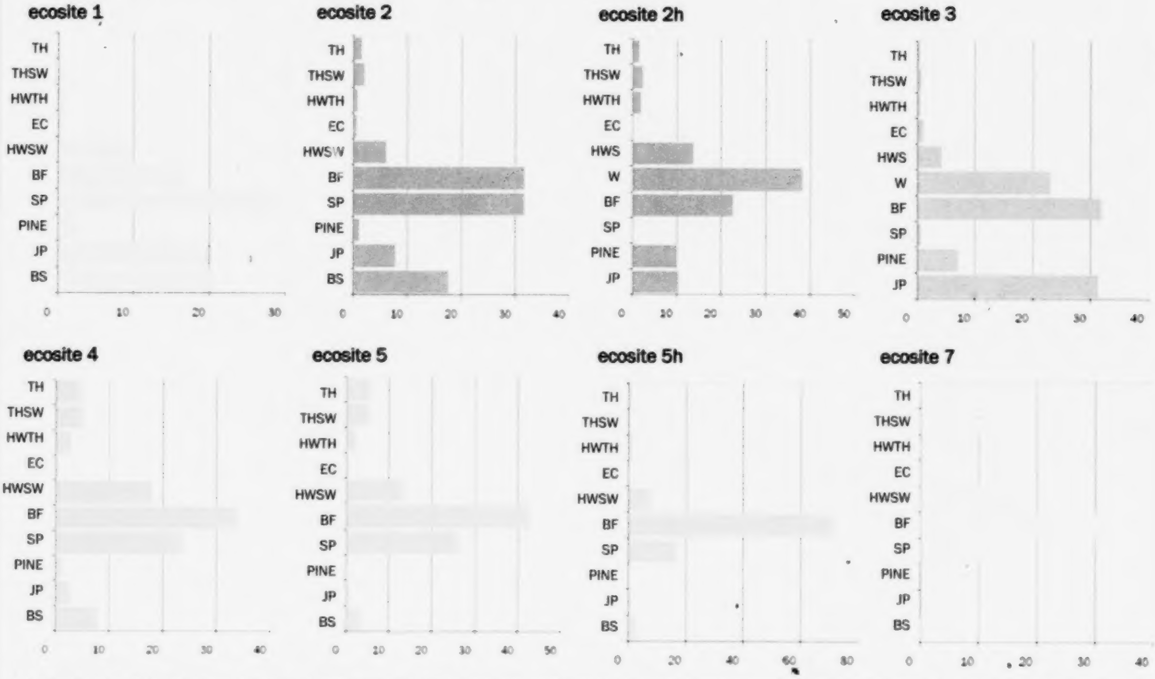
95% of Ganong Ecodistrict has forest cover

5% of Ganong Ecodistrict is not forested

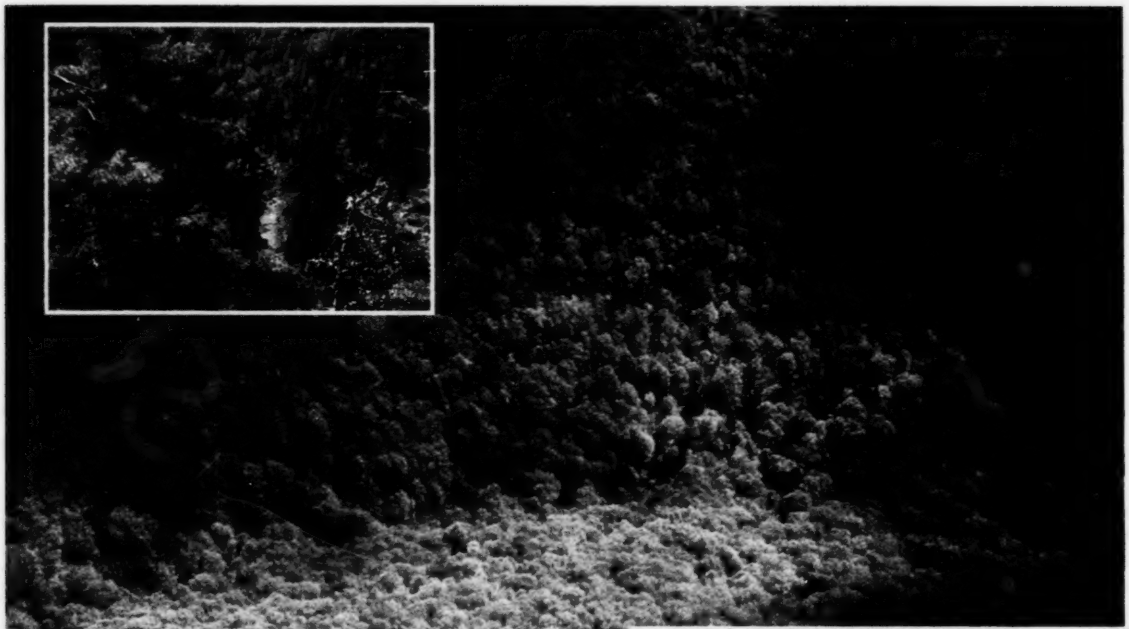




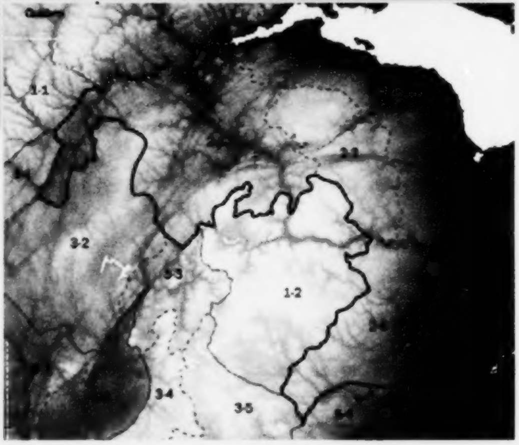
Percent cover of forest stand types by ecosite



Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.



The Northern Uplands Ecoregion has geological diversity that greatly influences the surface expression of the land and the makeup of its ecosystems.

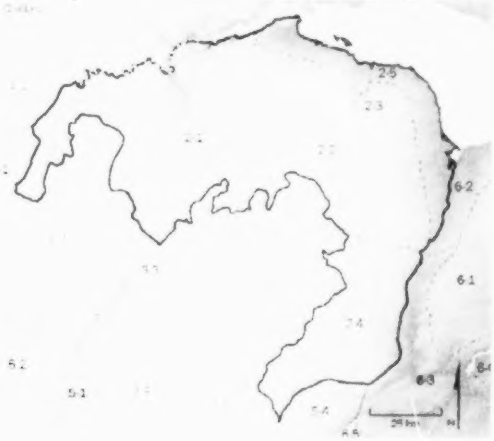


Chapter 8

2. Northern Uplands Ecoregion

The Northern Uplands Ecoregion arcs across northernmost New Brunswick between the two separate portions of the Highlands Ecoregion. Its northern edge borders the lower Restigouche River and Chaleur Bay, and its east side follows the geological contact between flat-lying sedimentary rocks and rugged igneous landscape. The ecoregion climatically is intermediate between the colder Highlands Ecoregion and the slightly warmer and wetter Central Uplands Ecoregion. Its vegetation and fauna consequently display a mixture of northern and southern affiliations that give the area an ecologically distinctive character.

The Northern Uplands Ecoregion has geological diversity that greatly influences the surface expression of the land and the makeup of its ecosystems.



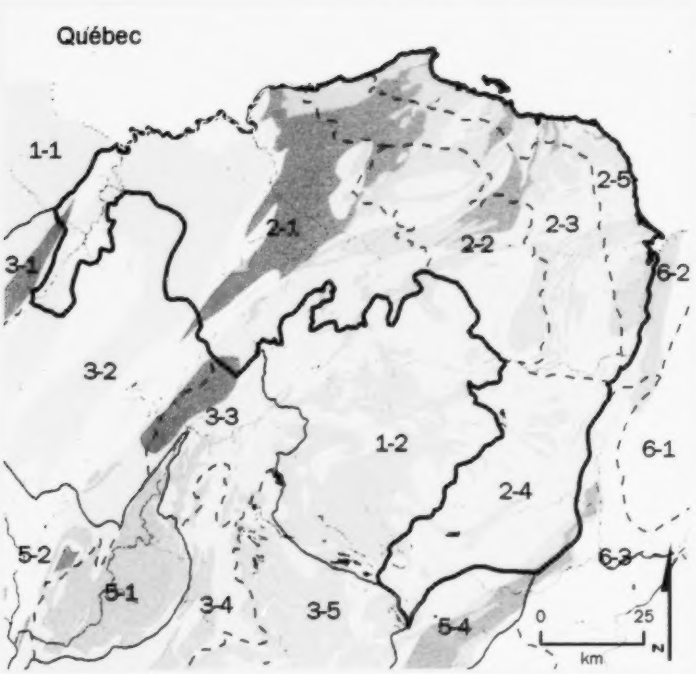
Chapter 8

2. Northern Uplands Ecoregion

The Northern Uplands Ecoregion arcs across northernmost New Brunswick between the two separate portions of the Highlands Ecoregion. Its northern edge borders the lower Restigouche River and Chaleur Bay, and its east side follows the geological contact between flat-lying sedimentary rocks and rugged igneous landscape. The ecoregion climatically is intermediate between the colder Highlands Ecoregion and the slightly warmer and wetter Central Uplands Ecoregion. Its vegetation and fauna consequently display a mixture of northern and southern affiliations that give the area an ecologically distinctive character.

Geology and Landscape

The Northern Uplands Ecoregioncomprises an assortment of Ordovician to Devonian metasedimentary rocks interfingered with granitic and volcanic rocks. The western half is dominated by a broadly uniform terrain of calcareous and non-calcareous metasedimentary rocks. The eastern area forms a quilt of mainly igneous rocks that end abruptly at the huge wedge of Carboniferous sedimentary rocks that cover much of central and eastern New Brunswick.



Geology of Northern Uplands Ecoregion

Rock Types

Highly calcareous sedimentary
Calcareous sedimentary
Non-calcareous sedimentary
Early Carboniferous sedimentary
Late Carboniferous sedimentary
Mafic volcanic
Felsic volcanic
Granites and granodiorites

Elevations in the region average about 150 to 300 meters, but descend from 522 meters at the summit of Blue Mountain down to sea level at the Chaleur Bay coast. The landscape generally is highest along the curved boundary with the Highlands Ecoregion and then dwindles gradually towards the coast. As a result, many slopes in the region have a northerly aspect – that is, they face north – which plays a significant role in determining local climate and vegetation.

The landscape has been deeply marked and incised by many legendary New Brunswick rivers: the Restigouche, Upsalquitch, Tetagouche, Jacquet, Northwest Miramichi, and Sevogle. These waterways and their tributaries subdivide the crescent-shaped region with a network of waterways that flow briskly down from the uplands towards Chaleur or Miramichi bays. Ancient glacial deposits along the Tetagouche River valley have blocked the flow of water sufficiently to create a chain of three small lakes; lakes otherwise are quite rare in the region.

Climate

The average annual temperatures of the Northern Uplands Ecoregion are warmer than in the adjacent Highlands Ecoregion, due to slightly lower elevations and a proximity to Chaleur Bay. Even so, the higher ground away from the Chaleur coast can be bitterly cold in winter. The region has roughly the same range of latitude and elevation as the warmer Central Uplands Ecoregion, yet experiences a cooler overall climate. This is probably because its mainly north-facing slopes receive less solar exposure (and hence have lower ambient temperatures) than the largely south- and west-facing slopes of the Central Uplands Ecoregion. Much of the Northern Uplands Ecoregion lies in the rain shadow of the mountainous Gaspé area of Quebec, and is markedly drier than the Highlands Ecoregion. Wildfire has been a regular occurrence here, due in part to the lower precipitation.

Forest Cover

Forests of the Northern Uplands Ecoregion show some affinities with the Valley and Eastern Lowlands ecoregions, owing to its dry climate; however, the cooler temperatures limit the distribution of species that commonly occur in those regions. Tolerant hardwoods such as sugar maple and yellow birch occur with some beech on well-buffered soils and along the hilltops at lower elevations. The more southerly species of ironwood and white ash are extremely scarce here. Cedar also can be found on calcareous soils in the warmer, northern ecodistricts.

The ecoregion encompasses the northern range limit of red spruce, beech and hemlock, all of which can be found at lower elevations. Black ash and balsam poplar form a distinctive association on river floodplains in the ecoregion.

As one moves inland and toward the higher elevations, coniferous cover becomes more prevalent. Forest of balsam fir with black spruce and white spruce dominate in areas of poor, volcanic-derived soils such as occur around the headwaters of the Benjamin and Jacquet rivers, and near Blue Mountain and Rocky Brook. Some river valleys feature white pine, red pine, and jack pine alongside the spruce and fir. White pine and trembling aspen are particularly common in these ecodistricts.

One notable site in the Upsalquitch River valley shelters an extensive stand of red pine accompanied by poplar and white pine with some largetooth aspen. The location seems to have been a 'hotspot' touched repeatedly by fire which, over time, encouraged the plentiful germination of these fire-adapted species.

The coniferous forests shelter a typical boreal assemblage of ground vegetation such as wood-sorrel, wood fern, and wild lily-of-the-valley. The stands of sugar maple, beech, and yellow birch are testament to a more moderate climate than the Highlands

Ecoregion. Even so, these stands lack the characteristic understorey species found in more southerly locations including spring beauty, bellwort, trout lily, and Christmas fern.

Wetlands

The wetlands of the Northern Uplands Ecoregion appear mainly as narrow zones alongside streams and rivers, dominated by a tangle of shrub swamp but often grading into marsh. Shallow open water wetlands tend to occur in proximity to ponds and streams nearer the coast. The eastern ecodistricts support several large peatlands, while salt marshes also can be found associated with some coastal estuaries. Of note are the marshes at the mouth of Restigouche River, home to several rare plant species and valuable habitat for migrating and nesting waterfowl.

2.1. Upsalquitch Ecodistrict

The Upsalquitch Ecodistrict lies in northern New Brunswick adjoining Québec and is separated from that province by the Restigouche River. The ecodistrict has a western panhandle that extends south through the village of Kedgwick River.

Geology

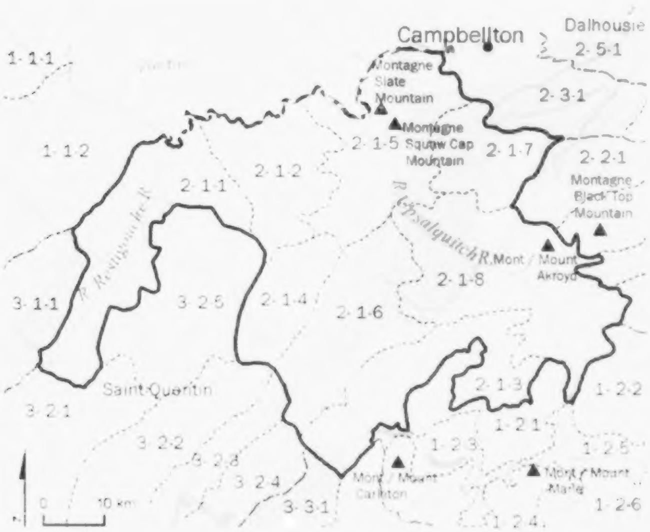
Bedrock in the north and the west areas of the ecodistrict is dominated by Ordovician calcareous and argillaceous metasedimentary strata with small intrusions of Devonian granitic rock that occur in the vicinity of Squaw Cap Mountain. The remainder of the terrain is underlain by an assemblage of northeast-trending Silurian to Devonian sedimentary rocks that are interbedded with mafic and felsic volcanic rocks. The sedimentary lithologies consist mainly of shale, siltstone and greywacke with limestone. Some of the calcareous Silurian rocks are particularly soft, whereas others are slightly more resistant to erosion.

Two major northeast-trending faults intersect the ecodistrict and are part of a regional structural pattern that has influenced the flow direction of rivers and lakes.

Geology of Upsalquitch Ecodistrict

Rock Types

- Highly calcareous sedimentary
- Calcareous sedimentary
- Non calcareous sedimentary
- Early Carboniferous sedimentary
- Late Carboniferous sedimentary
- Mafic volcanic
- Felsic volcanic
- Granites and granodiorites


Campbellton
Dalhousie
2-5-1
1-1-1
Montagne Slate Mountain
2-3-1
Montagne Squaw Cap Mountain
1-1-2
2-1-5
2-1-7
2-2-1
2-1-2
2-1-1
Montagne Black Top Mountain
R. Restigouche R.
Upsalquitch R.
Mont / Mount Akroyd
2-1-8
3-1-1
3-2-5
2-1-4
2-1-6
2-1-3
1-2-2
Saint-Quentin
3-2-1
1-2-1
3-2-2
1-2-3
1-2-5
3-2-3
Mont / Mount Carleton
Mont / Mount Marie
3-2-4
1-2-6
3-3-1
1-2-4
0
10 km
N

Ecoregion. Even so, these stands lack the characteristic understorey species found in more southerly locations including spring beauty, bellwort, trout lily, and Christmas fern.

Wetlands

The wetlands of the Northern Uplands Ecoregion appear mainly as narrow zones alongside streams and rivers, dominated by a tangle of shrub swamp but often grading into marsh. Shallow open water wetlands tend to occur in proximity to ponds and streams nearer the coast. The eastern ecodistricts support several large peatlands, while salt marshes also can be found associated with some coastal estuaries. Of note are the marshes at the mouth of Restigouche River, home to several rare plant species and valuable habitat for migrating and nesting waterfowl.

2.1. Upsalquitch Ecodistrict

The Upsalquitch Ecodistrict lies in northern New Brunswick adjoining Québec and is separated from that province by the Restigouche River. The ecodistrict has a western panhandle that extends south through the village of Kedgwick River.

Geology

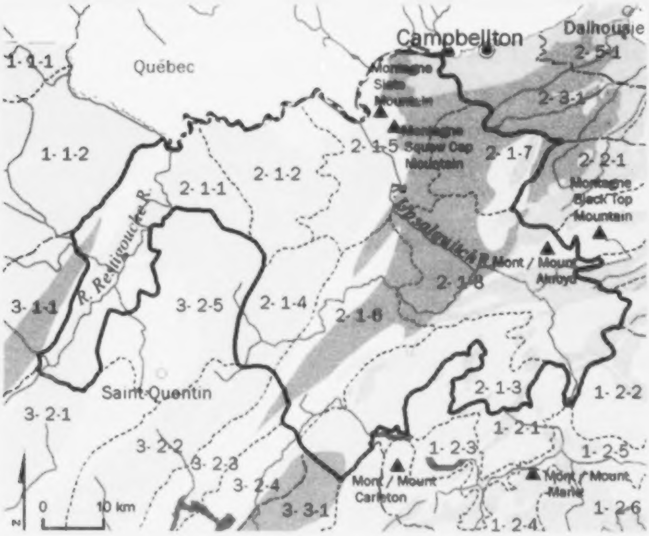
Bedrock in the north and the west areas of the ecodistrict is dominated by Ordovician calcareous and argillaceous metasedimentary strata with small intrusions of Devonian granitic rock that occur in the vicinity of Squaw Cap Mountain. The remainder of the terrain is underlain by an assemblage of northeast-trending Silurian to Devonian sedimentary rocks that are interbedded with mafic and felsic volcanic rocks. The sedimentary lithologies consist mainly of shale, siltstone and greywacke with limestone. Some of the calcareous Silurian rocks are particularly soft, whereas others are slightly more resistant to erosion.

Two major northeast-trending faults intersect the ecodistrict and are part of a regional structural pattern that has influenced the flow direction of rivers and lakes.

Geology of Upsalquitch Ecodistrict

Rock Types

Highly calcareous sedimentary
▨ Calcareous sedimentary
Non-calcareous sedimentary
▨ Early Carboniferous sedimentary
Late Carboniferous sedimentary
▨ Mafic volcanic
Felsic volcanic
▨ Granites and granodiorites


Québec
Campbellton
Dalhousie
1-1-1
1-1-2
2-1-1
2-1-2
2-1-5
2-1-7
2-5-1
2-3-1
2-2-1
Montagne Slate Mountain
Montagne Squaw Cap Mountain
Montagne Black Top Mountain
Mont / Mount Alroyd
R. Restigouche R.
Upsalquitch R.
2-1-8
2-1-6
2-1-4
3-1-1
3-2-5
Saint-Quentin
3-2-1
3-2-2
3-2-3
3-2-4
3-3-1
2-1-3
1-2-2
1-2-1
1-2-3
1-2-5
1-2-4
1-2-6
Mont / Mount Carleton
Mont / Mount Marie
0
10 km
N

Landscape and Climate

The landscape is etched by two major rivers: the Restigouche and the Upsalquitch. Together, they help to delineate a central plateau that lies roughly southwest of the Upsalquitch River and southeast of Boland Brook.

The Restigouche River passes through the village of Kedgwick River to drain the panhandle area before reaching the northwest border of the ecodistrict, at which point it is joined by the Patapedia River. Million Dollar Pool occurs at the juncture and reportedly is the most important salmon pool on the Restigouche River system. After the pool, the Restigouche continues on its way to Chaleur Bay, tracing the Quebec-New Brunswick border.

The Restigouche River, a Canadian Heritage River, winds its way through rolling terrain covered with mixed broadleaf and needle-leaved forest that is typical of the Upsalquitch Ecodistrict..

The Upsalquitch River begins in the southeast extremity at Upsalquitch Lake, then travels northwest gathering tributaries until it reaches Upsalquitch Forks. There, it joins the Northwest Upsalquitch river, which drains the southwest terrain, and, united, they rush downhill to meet the Restigouche in a tremendous confluence near Robinsonville.

Several lakes dot the terrain including Upsalquitch Lake and Popelogan Lake, which are associated with rivers of the same name. The bottom of the latter lake is covered in places with a deposit of marl, a highly calcareous clay material that can be used for a variety of commercial purposes.

This upland ecodistrict forms a geographic interlude between the even more rugged ecodistricts of the Highlands Ecoregion. Although its average elevation is only 300 meters it peaks at about 470 meters along the headwaters of Ritchie Brook. The many tributaries of the Restigouche, Northwest Upsalquitch and Upsalquitch rivers have incised the landscape continuously over geological time by as much as 180 m into a corrugation of steep, parallel gulches and ravines.

The ecodistrict has a moderately cold, wet climate and lies partially in the rain shadow of the Kejwik Ecodistrict in the Highlands Ecoregion. Average temperatures increase slightly across the area from east to west.

Soils

The soils of moderate to low inherent fertility are those associated with interbedded metavolcanic and metasedimentary bedrock. The metagreywackes comprise sandy loams with a high gravel content that belong to the McGee Unit and cover upper elevations in the central plateau area. Those obtained from argillite produce finer textured Victoria Unit soils and are found near Menneval.

The eastern terrain is overlain by soils derived from moderately calcareous sandstone, siltstone and slate. They are a mixture of non-compact tills of the Thibault Unit, plus compact tills of the Kedgwick Unit, and possess intermediate fertility.

The richest soils derive from argillaceous limestone and belong to the Caribou and Undine units. They occur intermittently in the central plateau along the Northwest Upsalquitch, Popelogan and Restigouche rivers. These deep, fine-textured, relatively neutral soils provide ample nutrients, rooting depth, and moisture for plant growth.

Biota

A combination of strong relief and high fire frequency has resulted in a diverse forest cover. Many of the upper slopes (7) in the central plateau support a mixed-forest community of balsam fir, sugar maple, red maple, yellow birch with occasional white spruce and beech.

The calcareous plateau (5c) along the mid-section of Upsalquitch River is dominated by a mixed community of sugar maple, balsam fir, yellow birch and beech. Limestone ridges (7c) tend to support tolerant hardwoods, and also host unusual calcareous-loving plants.

Grass-of-Parnassus is uncommon in New Brunswick but is often seen on calcareous shores in the Upsalquitch ecodistrict. Debby Peck photo.

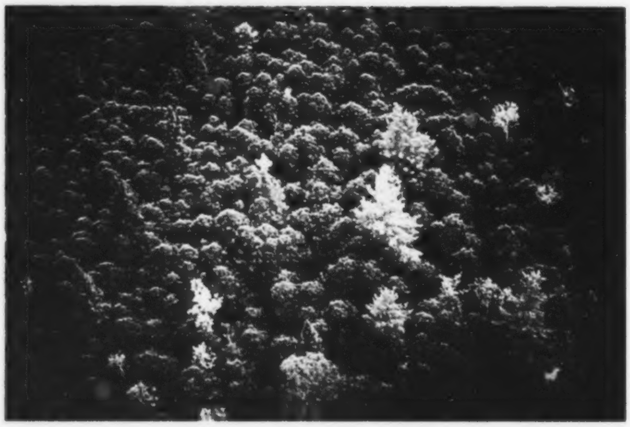
On poorly-drained calcareous soils such as flatter areas in the Restigouche and Upsalquitch river valleys (6c), mixtures of black spruce, white spruce, balsam fir and cedar prevail. On Interval soils subject to spring flooding (6f), balsam poplar and black ash are added to this mixture.

The steep valley slopes (4, 2c) more commonly support coniferous forests of balsam fir and white spruce with some white pine and black spruce. Within these forests is a provincially endangered plant called pine drops.

In the large areas of forest that were burned during the 1930s, balsam fir and white spruce often occur beneath an overstorey of intolerant hardwoods. The 1934 Restigouche fire affected about 745 sq km in the centre of the ecodistrict, creating an extensive cover of early successional growth with trembling aspen and white birch on all ecosites. Harvesting disturbances also have contributed to the propagation of these pioneering species.

Several interesting stands of pine occur in the Upsalquitch area. One is a knoll of century-old white pine northwest of Upsalquitch Forks. As well, banks of Upsalquitch River in places are covered with red pine and white pine stands.

The 55 km stretch of the Restigouche River between Jardine Brook on Little Main Restigouche and Million Dollar Pool received Canadian Heritage River status in 1998. Part of this stretch is within the Upsalquitch ecodistrict. Larry's Gulch in the designated zone hosts rare plants on its wet shaded limestone cliffs, including a small fern called the Northern Woodsia.



Red and white pine trees dominate a forest stand near Reid's Gulch on the Upsalquitch river.

Osprey occasionally can be glimpsed along riverbanks in this ecodistrict, whereas American pine marten and the Canada lynx prefer to roam the more secluded corners of this and other northern ecodistricts.

Settlement and Land Use

The name *Upsalquitch* derives from the Mi'kmaq *apsetkwechk* meaning 'little river', referring to the river's size compared with the larger Restigouche River. The Upsalquitch Ecodistrict lies within the traditional Mi'kmaq territory of Gespegeog. For at least 2500 years before European contact, aboriginals used the land regularly for hunting expeditions and for overland travel between the Saint John and Restigouche rivers. The salmon-rich Restigouche River was a primary source of food and a major transportation route.

Europeans began to establish trading posts and salmon fisheries in the coastal area around the mid-1600s. A village at Atholville down the coast was settled in the 1700s, but the more upriver villages such as Tide Head and Flatlands seem not to have been established much before the early 1800s.

Lumbering activities also began in the late 1700s, then escalated dramatically after the 1825 Miramichi Fires forced timber barons to move their focus northward into Restigouche country. By

1850 much of the large pine and spruce have been felled for ship masts, but numerous local sawmills continued to process the smaller logs being floated down the Upsalquitch and Restigouche rivers.

The lumbering communities of Kedgwick at the confluence of the Kedgwick and Restigouche rivers, and Upsalquitch on the Upsalquitch River, were almost the only inland settlements in the ecodistrict until the 1910 completion of the International Railway between Saint-Léonard and Campbellton. The railroad encouraged the growth of several railside communities such as Menneval and Felix Gulch.

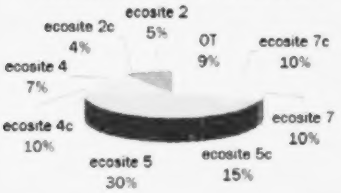
Today, the ecodistrict's few residents rely largely on tree harvesting, sawmills, and outfitting activities for their livelihood. Copper, lead, zinc, gold, silver, and uranium prospects have been discovered in the area over the last century but are not yet considered to have commercial potential.

2.1. Upsalquitch Ecodistrict at a Glance

Ecoregion: Northern Uplands
Area: 330,157 ha
Average elevation above sea level: 278 m
Average May–September precipitation: 475–500 mm
Average annual degree-days above 5°C: 1300–1450

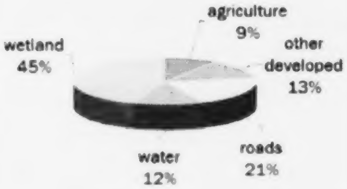
96% of Upsalquitch Ecodistrict has forest cover

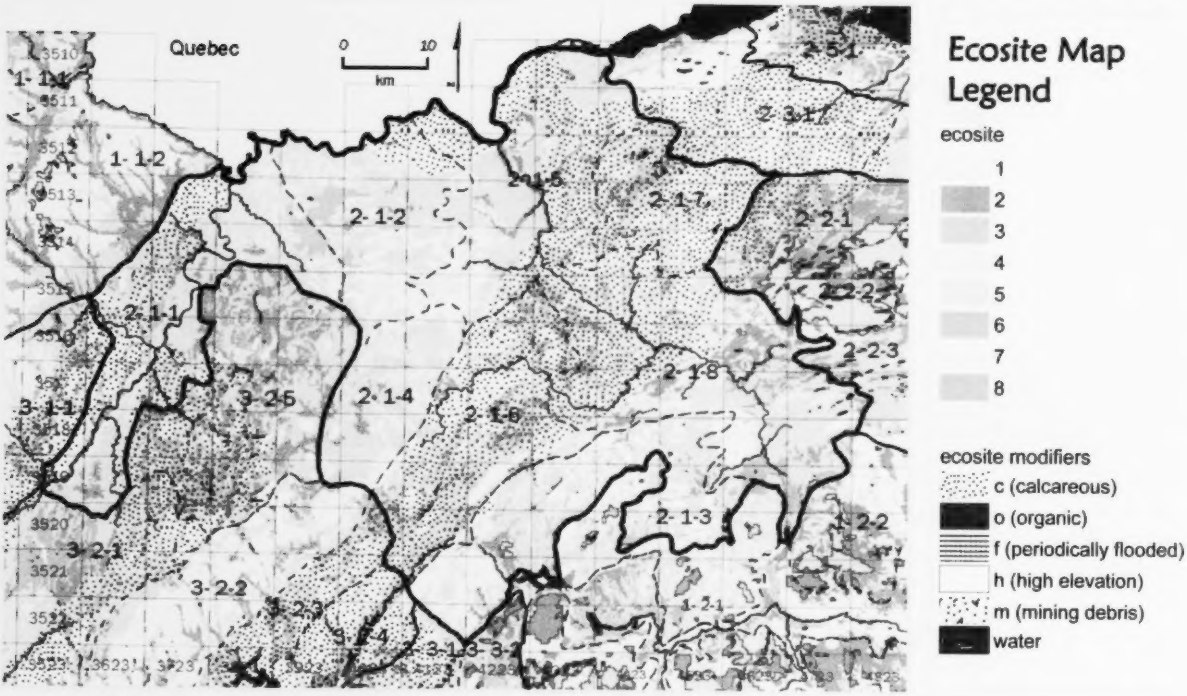
ecosite coverage of forest area



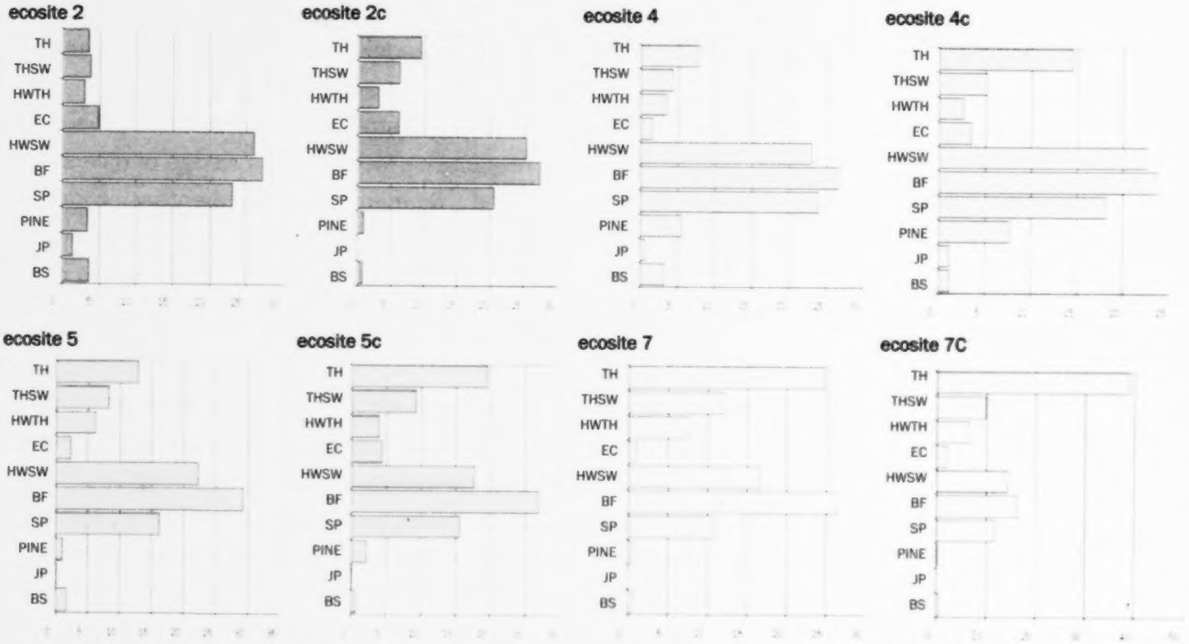
4% of Upsalquitch Ecodistrict is not forested

land uses of non-forest area

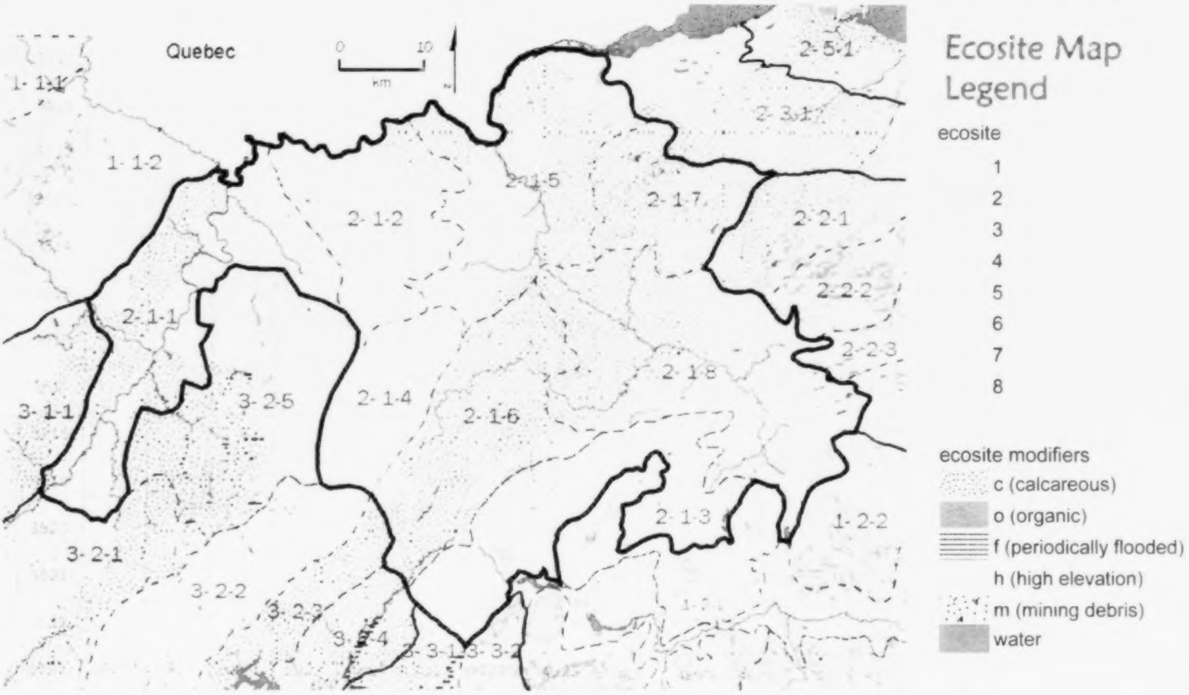



Quebec
0
10
km
1-1-1
1-1-2
3510
3511
3512
3513
3514
3520
3521
3522
3523
2-1-2
2-1-5
2-1-7
2-5-1
2-3-17
2-2-1
2-2-2
2-2-3
2-1-1
3-2-5
2-1-4
2-1-6
2-1-8
3-1-1
2-1-3
1-2-2
3-2-1
3-2-2
3-2-3
3-1-4
3-1-3
3-3-2
1-2-1
Ecosite Map Legend
ecosite
1
2
3
4
5
6
7
8
ecosite modifiers
c (calcareous)
o (organic)
f (periodically flooded)
h (high elevation)
m (mining debris)
water

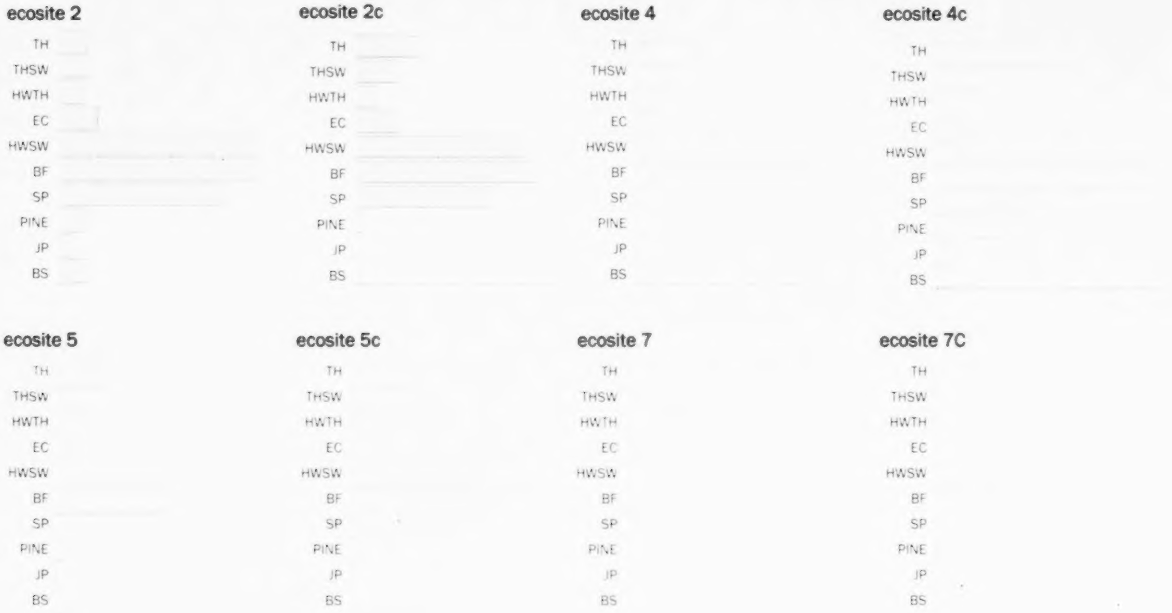
Percent cover of forest stand types by ecosite



Vertical axis: BS–black spruce; JP jack pine; PINE–white pine; SP–white spruce; BF–balsam fir; HWSW–intolerant hardwood and softwood species; EC–eastern white cedar; HWTH–intolerant hardwood and tolerant hardwood species; THSW–tolerant hardwood with softwood species; TH–tolerant hardwood species. **Horizontal axis**: percent cover.


Quebec
0 10
km
1-1-1
1-1-2
2-1-2
2-1-5
2-1-7
2-5-1
2-3-1
2-2-1
2-2-2
2-2-3
2-1-1
3-1-1
3-2-5
2-1-4
2-1-6
2-1-8
2-1-3
1-2-2
3-2-1
3-2-2
3-2-3
3-2-4
3-3-1
3-3-2
Ecosite Map Legend
ecosite
1
2
3
4
5
6
7
8
ecosite modifiers
c (calcareous)
o (organic)
f (periodically flooded)
h (high elevation)
m (mining debris)
water

Percent cover of forest stand types by ecosite



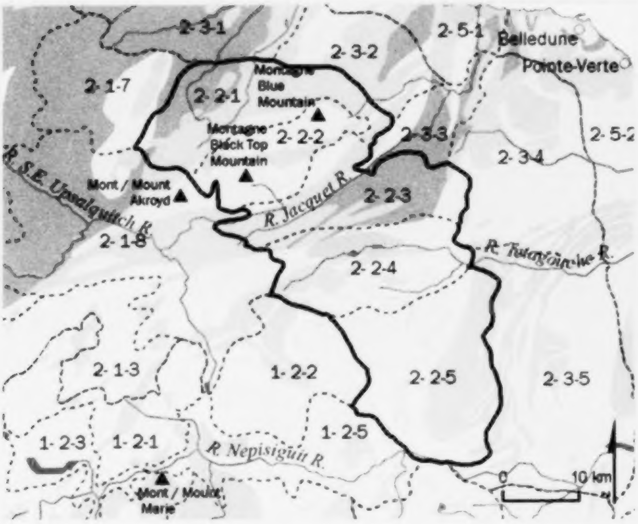
Vertical axis: BS–black spruce; JP jack pine; PINE–white pine; SP–white spruce; BF–balsam fir; HWSW–intolerant hardwood and softwood species; EC–eastern white cedar; HWTH–intolerant hardwood and tolerant hardwood species; THSW–tolerant hardwood with softwood species; TH–tolerant hardwood species. **Horizontal axis**: percent cover.

2.2. Tetagouche Ecodistrict

The Tetagouche Ecodistrict is situated in northern New Brunswick. It is a transitional area between the highlands of Ganong and Upsalquitch ecodistricts to the west and the lower terrain of the Tjigog Ecodistrict to the east.

Geology

The bedrock here appears in three basic divisions: a southern plateau of volcanic and metasedimentary rocks, a central wedge of sedimentary and metasedimentary strata, and a northern plateau of volcanic and metasedimentary rocks. Several regional northeast-trending faults offset the bedrock, the largest being the Rocky Brook-Millstream Fault. The southern plateau encompasses the area south of the Tetagouche River and is composed mainly of highly deformed Ordovician felsic and mafic volcanic rocks, with some calcareous metasedimentary rocks. The northern plateau lies north of the Jacquet River and is underlain by Silurian volcanic and metasedimentary rocks.


2-3-1
2-3-2
2-5-1
Belledune
Pointe-Verte
2-1-7
2-2-1
Montagne Blue Mountain
Montagne Black Top Mountain
2-2-2
2-3-3
2-5-2
2-3-4
R. S.E. Upsalquitch R.
Mont / Mount Akroyd
R. Jacquet R.
2-2-3
2-1-8
R. Tetagouche R.
2-2-4
2-1-3
1-2-2
2-2-5
2-3-5
1-2-3
1-2-1
1-2-5
R. Nepisiguit R.
Mont / Mount Marie
0
10 km

Geology of Upsalquitch Ecodistrict

Rock Types

Highly calcareous sedimentary

▨ Calcareous sedimentary

Non-calcareous sedimentary

▨ Early Carboniferous sedimentary

Late Carboniferous sedimentary

▨ Mafic volcanic

Felsic volcanic

▨ Granites and granodiorites

Between the northern and southern plateaus – that is, between about Jacquet River and Tetagouche River – lies a wedge of diverse rock types. Devonian and Silurian metasedimentary rocks predominate, but are partially covered by much younger Pennsylvanian conglomerates and sandstones that surround two of the three Tetagouche Lakes.

Landscape and Climate

The Jacquet and Tetagouche rivers transect the ecodistrict from west to east en route to Chaleur Bay and, together with their tributaries, are the ecodistrict's most obvious landscape feature.

The Jacquet River begins gently enough at source, but before long gathers enough momentum to sculpt the bedrock deeply into gorges that at some locales drop over 200 m. The river's south-flowing tributaries tumble down from the northern plateau into the main stream through a series of shadowed gulches.

The Tetagouche River lies further south flows more gently than does the Jacquet River. This has enabled a necklace of three small glacially influenced lakes to widen along its length: the Upper, Middle and Lower Tetagouche. Only after leaving Lower Tetagouche Lake does the river gain enough energy to noticeably incise the bedrock and develop rapids. Other lakes in the area include Black Lake, known for its extremely cold summer temperatures, and California Lake.

New Brunswick has two Blue Mountains. One occurs in this ecodistrict, and the other lies just east of Tobique River on the border of Wapske and Serpentine ecodistricts. Blue Mountain and Black Top Mountain preside over the northern plateau and are underlain by felsic volcanic rocks. The summit of Blue Mountain at 522 m is the highest point in the ecodistrict and, with its blanket of grey-blue conifers, lends a quiet grandeur to the terrain. Relief elsewhere is generally moderate except for where rivers have etched the bedrock.

The Tetagouche Ecodistrict is intermediate in elevation between the highlands of Ganong and Upsalquitch ecodistricts to its west, and the lowlands of Tjigog Ecodistrict to its east. The highlands of the Gaspé Peninsula create a partial rain shadow that gives the ecodistrict a moderately dry, cool climate. Average summer precipitation diminishes from west to east across the landscape.

Soils

Areas underlain by felsic volcanic rocks are associated with shallow stony soils of the Lomond Unit, which are present on hilltops such as the ridges southwest of Blue Mountain. Compact loams to sandy loams of the Popple Depot Unit are more prevalent along middle to lower slopes in felsic bedrock areas. Felsic volcanic rocks weather slowly to yield highly acidic soils of low fertility.

In areas underlain by mafic volcanic rocks, the upper slopes and hillcrests tend to be covered by shallow, non-compact tills of the Mafic Volcanic Unit, whereas the middle and lower slopes are blanketed by deeper, loamy soils of the Tetagouche Unit. Both units possess intermediate fertility. The sandy loam soils derived from non-calcareous metasedimentary rocks also have only moderate fertility.

Soils derived from calcareous siltstone and sandstone are associated with the Carleton and Thibault units and tend to be a mixture of compact and non-compact loams. These fertile soils occur over the central wedge between Jacquet and Tetagouche rivers and also overlie the upper reaches of South Charlo River.

Biota

The northern plateau is covered by a widespread coniferous forest that consists mainly of balsam fir with some white spruce and black spruce (ecosite 2h). Lower McNair Brook east of Blue Mountain typifies a forest of this type. It has a balsam fir and black spruce canopy protecting succulent undergrowth, all thriving on a terrain intersected by narrow stream gorges with dramatic slopes approaching the vertical.

The acidic mid-slopes (5), and the lower slopes and flatlands (2), are composed mainly of spruce and pine. The acidic upper slopes (7) have a greater proportion of broad-leaved tree species with sugar maple, yellow birch in combination with balsam fir, white spruce, red maple and white birch. Beech reaches its climatic limit in the ecodistrict and is generally found only below elevations of 400 m.

In more calcareous regions, the mid-slopes (5c) have a strong balsam fir and mixed-forest component, whereas steeper valley slopes (2c) support black spruce and pine. Both coniferous and mixed forests occur on the slopes descending toward the Tetagouche Lakes.

Stands dominated by cedar with balsam fir, white spruce and black spruce are found on wet sites along rivers (6, 6c) and moist, gently sloping flatlands (3).

The intolerant hardwood community consists of white birch and trembling aspen, with balsam fir and occasional spruce.

Settlement and Land Use

The Tetagouche Ecodistrict lies within the traditional Mi'kmaq ecodistrict of Gespegeog. For at least the last 2500 years, aboriginals from the adjacent coastal communities used Jacquet River and other waterways to hunt, fish, and travel overland.

Some sources suggest that the name *Tetagouche* originated with the Mi'kmaq *odoodooguech*, meaning squirrel, although the relationship between river and rodent seems a little tenuous. Whatever its true derivation, the river and lakes were being called *toutgouch* (hence, Tetagouche) by 1686, shortly after French explorers began to visit the nearby coastal areas.

It is not known when Europeans initially ventured into the ecodistrict. The most likely initial inroad was Tetagouche River, and it seems plausible that prospectors and others explored the river's upper reaches throughout the early 1800s. Lumbermen began to seriously exploit forests in the area at this time, starting along the most easily accessible river valleys.

Today, tree harvesting is conducted in the area by various Crown Land leaseholders. Temporary lumber camps aside, the ecodistrict is very sparsely populated. Mineral occurrences of base and precious metal deposits are scattered throughout the terrain, but appear concentrated in volcanic rocks of the Tetagouche Group.

2.2. Tetagouche Ecodistrict at a Glance

Ecoregion: Northern Uplands

Area: 128, 029 ha

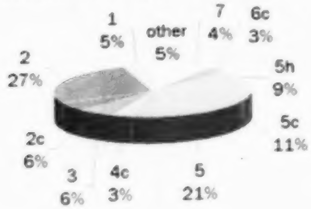
Average elevation above sea level: 350 m

Average May–September precipitation: 450–500 mm

Average annual degree-days above 5°C: 1400–1500

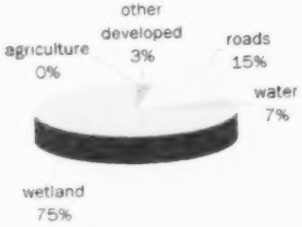
95% of Tetagouche Ecodistrict has forest cover

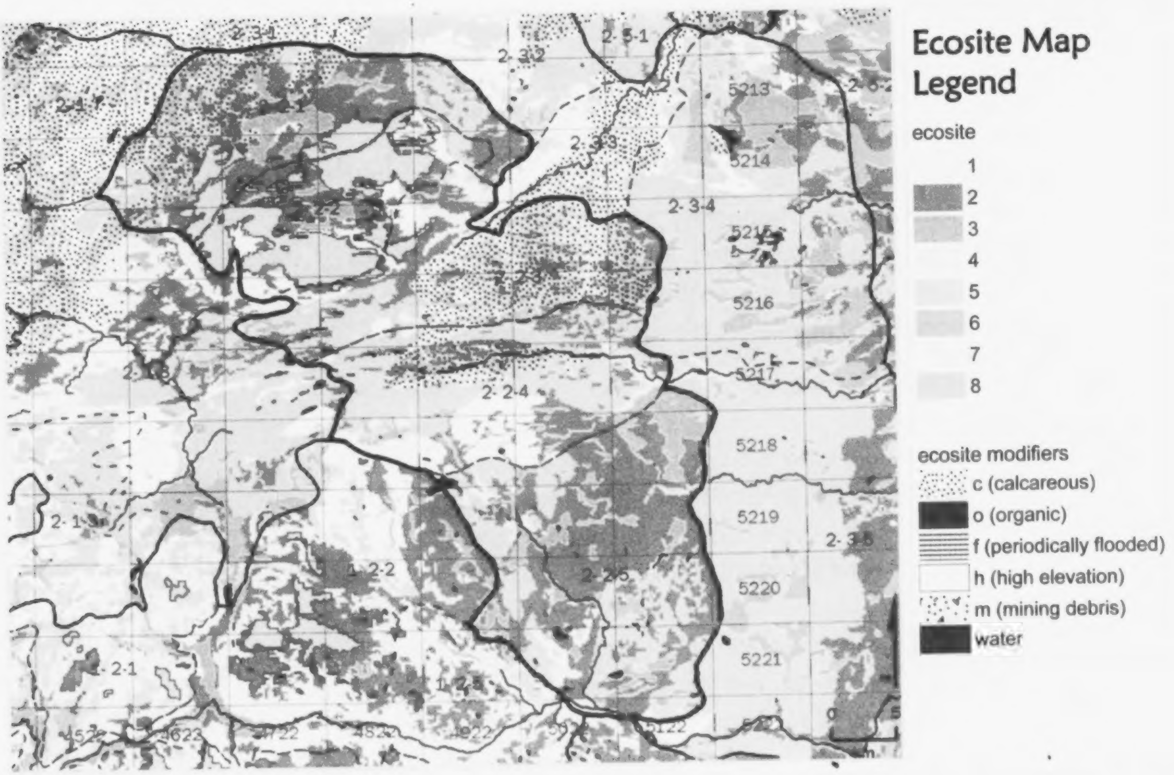
ecosite coverage of forest area



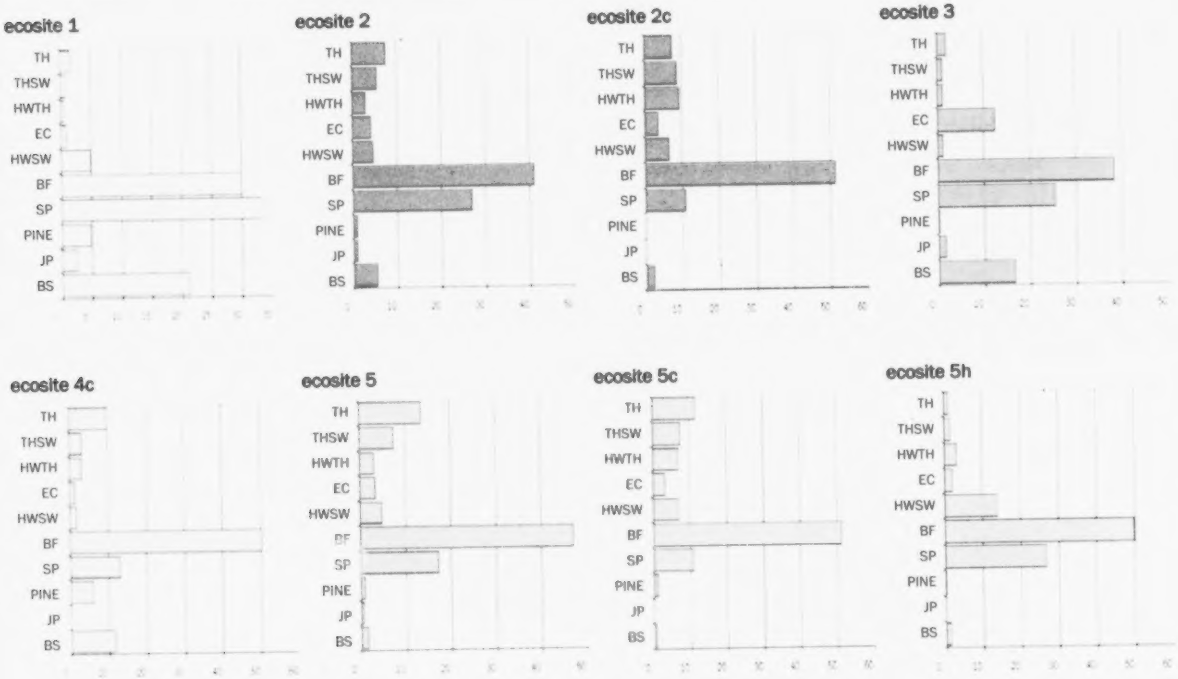
5% of Tetagouche Ecodistrict is not forested

uses of non-forest area

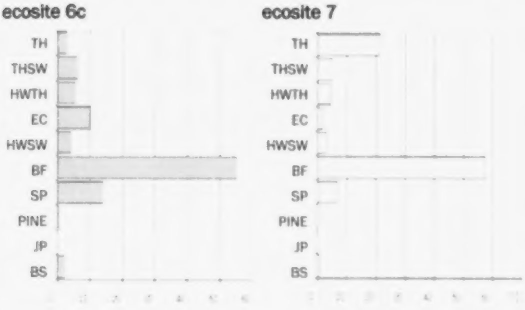



Ecosite Map Legend
ecosite
1
2
3
4
5
6
7
8
ecosite modifiers
c (calcareous)
o (organic)
f (periodically flooded)
h (high elevation)
m (mining debris)
water
2-3-1
2-3-2
2-3-3
2-3-4
2-3-5
2-2-4
2-2-5
2-1-3
2-1
1-2-2
1-2-5
5213
5214
5215
5216
5217
5218
5219
5220
5221
4623
4722
4822
4922
5122

Percent cover of forest stand types by ecosite



Percent cover of forest stand types by ecosite



Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.

2.3 Tjigog Ecodistrict

Tjigog Ecodistrict is a crescent-shaped inland plateau in northern New Brunswick that parallels the shape of Chaleur Bay between Bathurst and Dalhousie.

Geology

The bedrock here occurs in two broad sections: a southern terrain of Ordovician volcanic and metasedimentary rocks, and a northern terrain of Silurian to Devonian volcanic and metasedimentary rocks, with intrusions of Devonian granite and gabbro. The landscape is intersected by a series of major and minor northeast-trending faults, the largest of which is the Rocky Brook-Millstream Fault.

The southern terrain extends south from Millstream River and is underlain by Ordovician rocks of the Tetagouche Group. These highly folded and deformed rocks consist primarily of felsic and mafic volcanic rocks with some non-calcareous meta-sedimentary rocks including schist, slate, and phyllite.

The terrain north of the Millstream River contains Silurian

Geology of Tjigog Ecodistrict

Rock Types

Highly calcareous sedimentary

▨ Calcareous sedimentary

Non-calcareous sedimentary

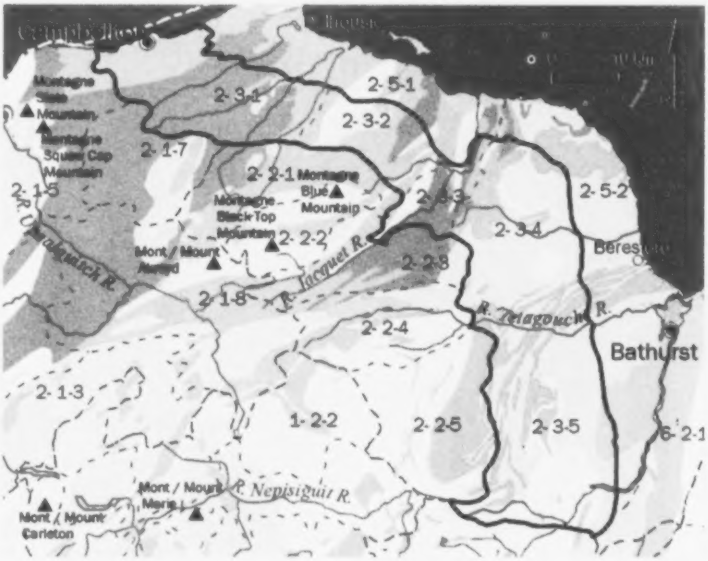
Early Carboniferous sedimentary

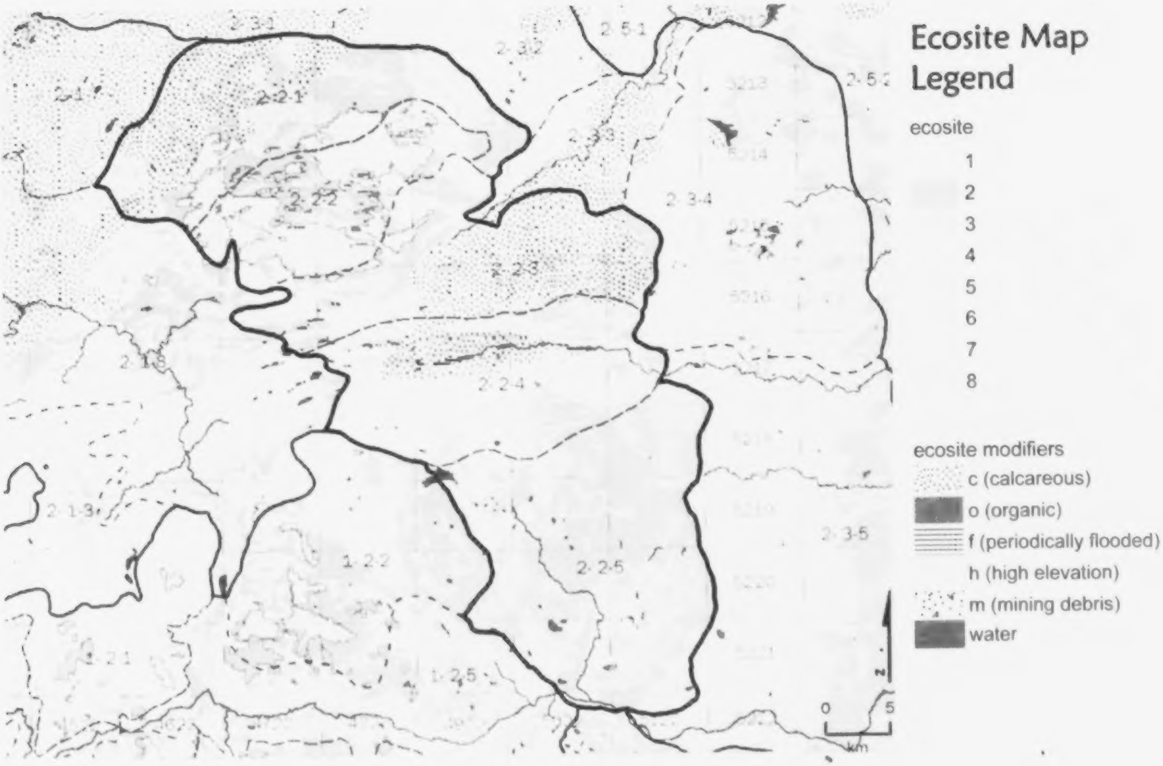
Late Carboniferous sedimentary

Mafic volcanic

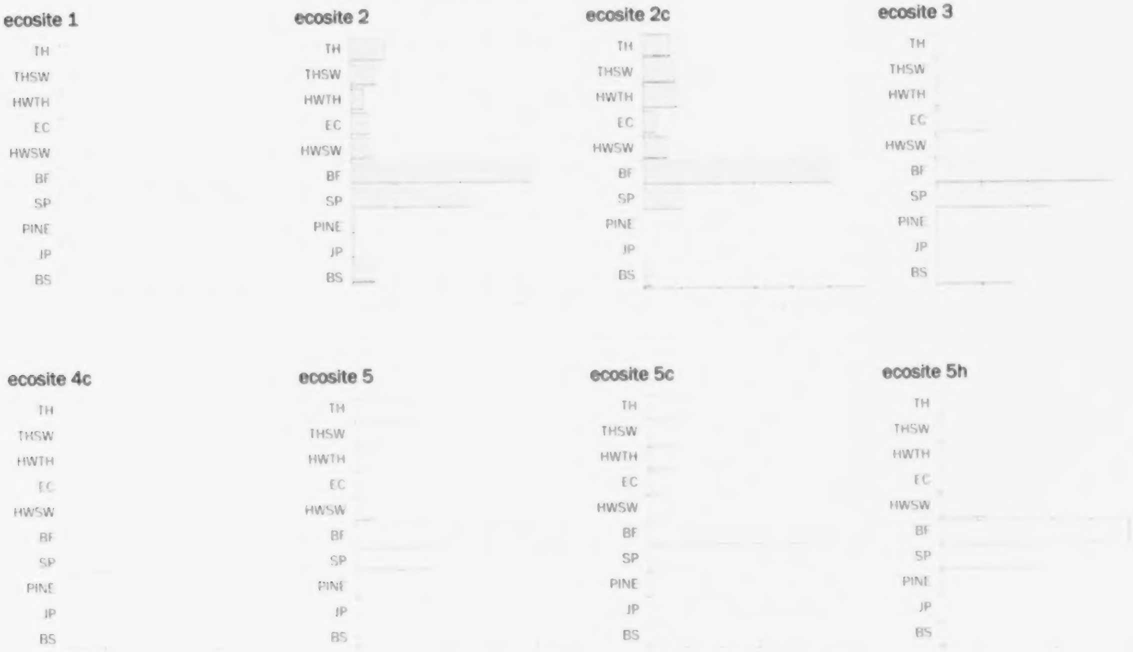
Felsic volcanic

Granites and granodiorites


Campbellton
2-5-1
2-3-1
2-3-2
Montagne Slate Mountain
Montagne Squaw Cap Mountain
2-1-7
2-2-1
Montagne Blue Mountain
2-1-5
Montagne Black Top Mountain
2-2-2
R. Upsalquitch R.
Mont / Mount Alward
Jacquet R.
2-3-3
2-5-2
2-3-4
Beresford
2-2-8
2-1-8
R. Tetagouche R.
2-2-4
Bathurst
2-1-3
1-2-2
2-2-5
2-3-5
6-2-1
Mont / Mount Marie
R. Nepisiguit R.
Mont / Mount Carleton


Ecosite Map Legend
ecosite
1
2
3
4
5
6
7
8
ecosite modifiers
c (calcareous)
o (organic)
f (periodically flooded)
h (high elevation)
m (mining debris)
water
0
5
km
2-3-1
2-3-2
2-5-1
2-5-2
2-1
2-2-1
2-2-2
2-3-3
2-3-4
2-2-3
2-1-8
2-2-4
2-1-3
1-2-2
2-2-5
2-3-5
2-2-1
1-2-5

Percent cover of forest stand types by ecosite



Percent cover of forest stand types by ecosite

Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.

2.3 Tjigog Ecodistrict

Tjigog Ecodistrict is a crescent-shaped inland plateau in northern New Brunswick that parallels the shape of Chaleur Bay between Bathurst and Dalhousie.

Geology

The bedrock here occurs in two broad sections: a southern terrain of Ordovician volcanic and metasedimentary rocks, and a northern terrain of Silurian to Devonian volcanic and metasedimentary rocks, with intrusions of Devonian granite and gabbro. The landscape is intersected by a series of major and minor northeast-trending faults, the largest of which is the Rocky Brook-Millstream Fault.

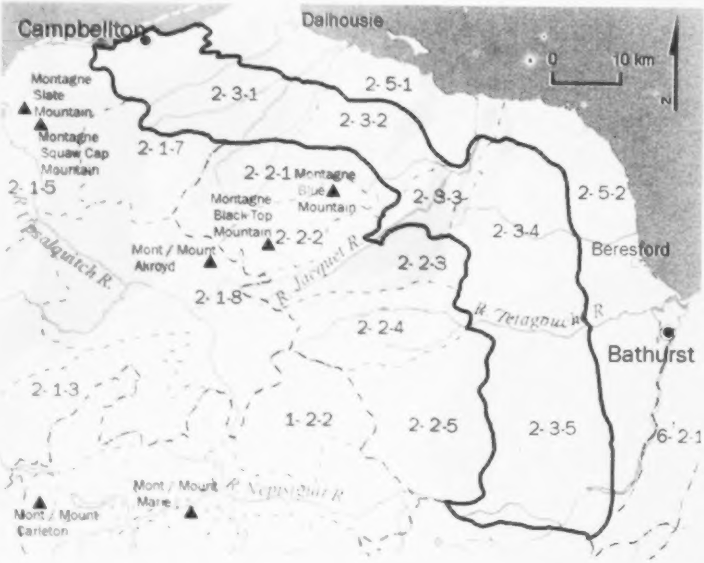
The southern terrain extends south from Millstream River and is underlain by Ordovician rocks of the Tetagouche Group. These highly folded and deformed rocks consist primarily of felsic and mafic volcanic rocks with some non-calcareous meta-sedimentary rocks including schist, slate, and phyllite.

The terrain north of the Millstream River contains Silurian

Geology of Tjigog Ecodistrict

Rock Types

- Highly calcareous sedimentary
- Calcareous sedimentary
- Non-calcareous sedimentary
- Early Carboniferous sedimentary
- Late Carboniferous sedimentary
- Mafic volcanic
- Felsic volcanic
- Granites and granodiorites


Campbellton
Dalhousie
0
10 km
N
Montagne Slate Mountain
Montagne Squaw Cap Mountain
2-3-1
2-5-1
2-3-2
2-1-7
2-2-1
Montagne Blue Mountain
Montagne Black Top Mountain
2-1-5
2-3-3
2-5-2
2-2-2
2-3-4
R. Upsalquitch R.
Mont / Mount Akroyd
R. Jacquet R.
2-2-3
Beresford
2-1-8
R. Tetagouche R.
2-2-4
Bathurst
2-1-3
1-2-2
2-2-5
2-3-5
6-2-1
Mont / Mount Marie
R. Nepisiguit R.
Mont / Mount Carleton

felsic and mafic volcanic rocks with calcareous metasedimentary rocks. It also includes younger, Lower Devonian mafic volcanic and calcareous metasedimentary rocks. Both the Silurian and Lower Devonian lithologies have been intruded by Upper Devonian granitic and gabbroic plutons.

View from the east of the City of Campbellton. The round-topped mountain on the left is Sugarloaf Mountain.

Sugarloaf Mountain near Campbellton represents a Devonian volcanic neck that became plugged with felsic lava during the final stages of volcanism.

Landscape and Climate

The Tjigog Ecodistrict represents an undulating plateau that reaches from the Nepisiguit River in the south to the North Charlo River in the north, beyond which the land drops abruptly to Campbellton and Chaleur Bay.

Waterways are a dominant landscape feature. Numerous streams and rivers interrupt the terrain as they race or meander downslope to Chaleur Bay. Many of the rivers display a northeasterly flow that reflects the regional trend of bedrock faulting.

The largest rivers – Jacquet, Tetagouche and Nepisiguit – have incised the bedrock in places to create breathtaking gorges. One of the more delightful spots is Tetagouche Falls where the Tetagouche River slides through a canyon before becoming a waterfall that tumbles over Ordovician slate and volcanic rocks.

The Upper Jacquet River and Lower South Branch Jacquet River have remote and inaccessible gorges that rise 350 meters in less than half a kilometre.

Antinouri Lake.

The largest lake in the ecodistrict is Antinouri Lake, which straddles a contact between a large Devonian granite pluton and Ordovician metasedimentary rocks. The relatively impermeable nature of the granite likely contributed to the lake's formation. Nigadoo Lake, at the headwaters of the Nigadoo River, is notable for its depth (nearly 30 m).

The Tjigog Ecodistrict is transitional between the higher elevation Tetagouche Ecodistrict to the southwest, and the low-lying Nicolas Denys Ecodistrict to the northeast. Elevation dwindles from about 300 m in the west to 100 m in the east, but relief is otherwise minimal except where rivers deeply dissect the bedrock.

The climate here is somewhat warmer than in the higher elevation ecodistricts to the west, and is moderated by its proximity to Chaleur Bay. The land lies partially in the rain shadow of the highlands to the west and north (Gaspé peninsula) and so receives medium to low precipitation during the growing season.

Soils

The mafic volcanic bedrock on hills and ridges south of Campbellton have produced stony residual soils of the Mafic Volcanic Unit, which are moderately fertile. Where calcareous sedimentary rocks underlie steep slopes, soils have developed as non-compact, sandy loams and loams of the Thibault Unit such as are present in the Jacquet River and Charlo River valleys. Where these rocks occur in gentler terrain, they develop as the compact, mostly finer textured tills of the Carleton and Kedgwick units.

Compact, medium-textured soils derived from a mixture of metasedimentary and igneous rocks and belonging to the Long Lake Unit dominate the southern section between the Tetagouche and Nepisiguit rivers.

Biota

The relatively warm waters of Chaleur Bay moderate the temperatures here, causing an extended growing season and encouraging species that otherwise would be less abundant at this latitude. A site just west of South Tetagouche, for instance, supports a grove of red oak which is uncommon in the north of the province.

The calcareous and moderately acidic upper slopes (7c, 7) are associated with mixed forests of sugar maple and yellow birch with balsam fir; beech becomes more dominant in the east. One such mixed forest occurs at Prichard Lake near Sugarloaf Mountain and features beech, ash, and Canada yew.

The steeper, dry slopes in calcareous areas (2c) such as along the Jacquet River support white pine and black spruce. Conversely, the strongly acidic mid-slopes (5) and flatlands (2) are blanketed by coniferous forests that commonly consist of balsam fir, red spruce and black spruce.

The ecodistrict's widespread intolerant hardwood community reflects the combined influences of fire and logging and is typified by trembling aspen and white birch.

Cedar and black spruce are associated with wet flatlands and gentle slopes (3, 6). A fine representative cedar stand is located in a swamp just north of the Nepisiguit River near Bathurst Mines and contains century-old

The Jacquet River has a steep-sided valley over much of its length.

eastern white cedar.

The Booming Grounds at Tide Head has been designated as an Eastern Habitat Joint Venture site and includes 118 ha of wooded alluvial islands, tidal wetlands, and shoreline. It provides shelter for migrating and nesting waterfowl, as well as habitat for great blue heron, osprey, and mammals. Uncommon plants within the designated area include Nuttell's waterweed, creeping rush and yellow sanicle.

Settlement and Land Use

The Tjigog Ecodistrict lies within the traditional Mi'kmaq territory of Gespegeog. The aboriginal village of Tjigog was located near present-day Atholville and was a major pre-contact settlement for at least 2500 years. People lived on the coast for much of the year, spearing fish, gathering crustaceans, and hunting birds and seals.

In the middle to late 1700s, European traders were granted land in and around the aboriginal village site, forcing its original inhabitants to move elsewhere. Early British merchants established coastal settlements and erected salmon-pickling factories, taking advantage of the area's location near the mouth of the Restigouche River with its bountiful salmon resources.

After the 1825 Miramichi Fires destroyed huge tracts of forest in central New Brunswick, lumbermen swarmed north into the Nepisiguit, Jacquet, and Tetagouche river valleys seeking easily accessible timber. Shipbuilding facilities and sawmills were erected at Campbellton and Atholville, and logging joined commercial fishing as an economic mainstay of the area. The 1875 completion of the International Railway from Saint-Léonard provided an additional economic boon, and turned Campbellton into a major railway centre. Campbellton and Atholville are now the major communities in the ecodistrict.

Forest lands in the area are presently held by two Crown Land leaseholders and several non-industrial and large private woodlot owners.

Between 1950 and 1982, dimension stone was quarried from a Devonian granite quarry at Antinouri Lake. It was used to erect several New Brunswick buildings including Notre-Dame-des-Sept-Douleurs Church in Edmundston.

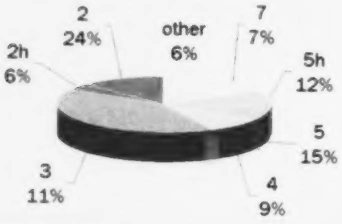
The rocks here are rich in base metals and other economic minerals. Large-scale mining within the ecodistrict begin with the opening of the massive Brunswick lead-zinc operation southwest of Bathurst in the 1950s. Today, the No. 12 is one of the largest zinc producer in the world.

2.3. Tjigog Ecodistrict at a Glance

Ecoregion: Northern Uplands
Area: 159, 454 ha
Average elevation above sea level: 205 m
Average May–September precipitation: 400–450 mm
Average annual degree-days above 5°C: 1450–1550

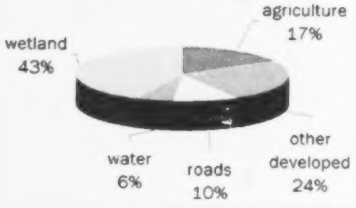
91% of Tjigog Ecodistrict has forest cover

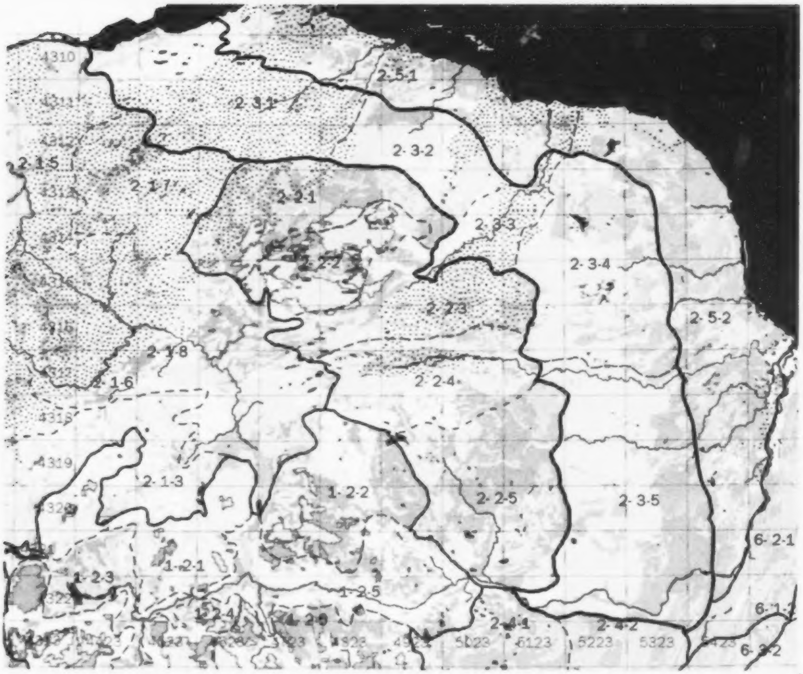
ecosite coverage of forest area



9% of Tjigog Ecodistrict is not forested

uses of non-forest area




4310
4311
4312
4313
4314
4316
4318
4319
4320
4322
2-5-1
2-3-1
2-3-2
2-1-5
2-1-7
2-2-1
2-2-2
2-3-3
2-3-4
2-2-3
2-5-2
2-1-8
2-1-6
2-2-4
2-1-3
1-2-2
2-2-5
2-3-5
6-2-1
1-2-1
1-2-3
1-2-5
1-2-4
2-2-6
2-4-1
2-4-2
6-1-2
6-3-2
4923
5023
5123
5223
5323

Ecosite Map Legend

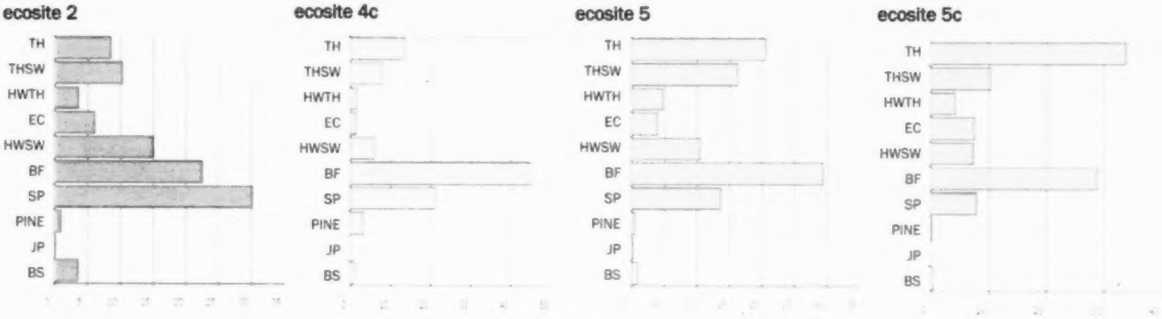
ecosite

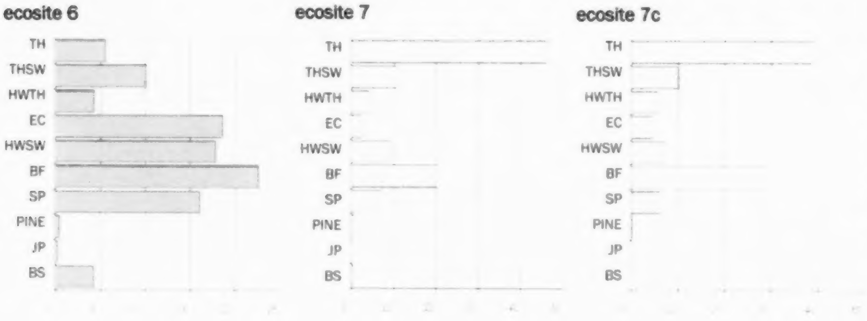
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

ecosite modifiers

- c (calcareous)
- o (organic)
- f (periodically flooded)
- h (high elevation)
- m (mining debris)
- water

Percent cover of forest stand types by ecosite





Vertical axis: TH—tolerant hardwood species; THSW—tolerant hardwood with softwood species; HWTH—intolerant hardwood and tolerant hardwood species; EC—eastern white cedar; HWSW—intolerant hardwood and softwood species; BF—balsam fir; SP—red or white spruce; PINE—white pine; JP jack pine; BS—black spruce
Horizontal axis: percent cover.

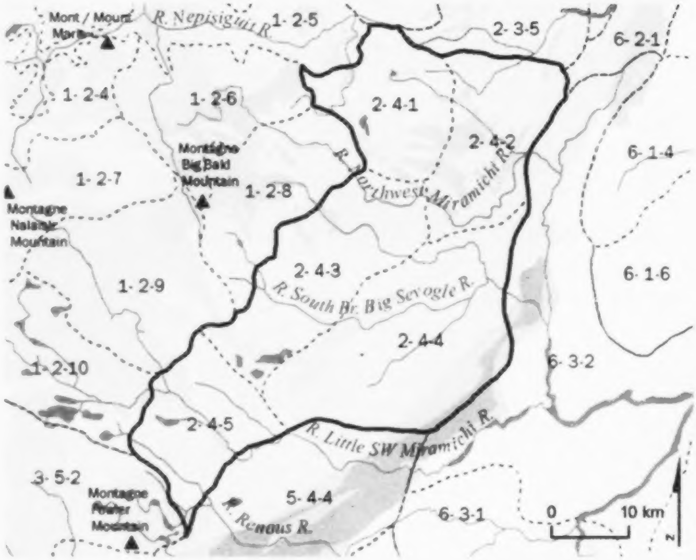
2.4. Tomogonops Ecodistrict

Tomogonops Ecodistrict is a gently rolling portion of northeast New Brunswick that is transitional between the mountainous Ganong Ecodistrict to the west and the low-lying Red Bank Ecodistrict to the east.

Geology

Rocks in the Tomogonops Ecodistrict occur in two distinct physiographic areas, separated by a fault that trends southeastward across the ecodistrict beginning at South Little River Lake.

The northern section contains Ordovician metavolcanic and metasedimentary rocks of the Tetagouche Group and is intersected by a web of northeast-trending faults. The volcanic rocks include rhyolite, metabasalt and sericite schist; the metasedimentary rocks are non-calcareous and consist mainly of phyllite, slate, and greywacke.


Mont / Mount
R. Nepisiguit R.
1- 2-5
2- 3-5
6- 2-1
1- 2-4
1- 2-6
2- 4-1
2- 4-2
6- 1-4
Montagne Big Bald Mountain
1- 2-7
1- 2-8
R. Northwest Miramichi R.
Montagne
Mountain
1- 2-9
2- 4-3
R. South Br. Big Sevogle R.
6- 1-6
2- 4-4
1- 2-10
6- 3-2
2- 4-5
R. Little SW Miramichi R.
3- 5-2
Montagne Fowler Mountain
5- 4-4
R. Renous R.
6- 3-1
0
10 km
N

Geology of Tomogonops Ecodistrict

Rock Types

Highly calcareous sedimentary

Calcareous sedimentary

Non-calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites

The southern section covers the lower two-thirds of the ecodistrict. It is underlain primarily by Ordovician metasedimentary strata, mainly phyllite, metaquartzite, and metagreywacke. These rocks also belong to the Tetagouche Group but are slightly older than those in the northern division.

A band of metamorphosed Ordovician granite interrupts the metasedimentary terrain, forming a crescent-shaped body that parallels Guagus Stream and Mullin Stream Lake before trending northeast to Sheephouse Brook.

Landscape and Climate

The Tomogonops Ecodistrict is a zone of topographic transition between the Ganong Ecodistrict and the Red Bank Ecodistrict. The rugged hills along the western Tomogonops Ecodistrict border echo the highlands of Ganong Ecodistrict and average about 500 m in elevation. Moving eastward, the altitude drops steadily to about 140 m on the eastern boundary where the land merges with more subdued topography.

Many rivers in the Tomogonops Ecodistrict – the North Sevogle, South Sevogle, Clearwater, Guagus, Northwest Miramichi, North Branch Renous and others – have their modest beginnings in the mountainous Ganong Ecodistrict. Gathering water and momentum as they tumble from the highlands, the rivers cross the border into Tomogonops, then journey east towards the same destination: the north-trending arm of Northwest Miramichi River, which lies just beyond the eastern margin.

North Branch of the Big Sevogle River, above squirrel Falls.

During their passage from west to east, the rivers interact with bedrock and topography to create spots of remarkable beauty. One site, Square Forks, is so breathtaking that early naturalist William Ganong felt moved to describe it as 'one of the most notable localities of New Brunswick'. Here, the North and South Branches of Big Sevogle River meet head-on in a gorge, and then turn their mingled waters together at right angles to flow into another canyon.

As might be expected in an inclined landscape of many rivers, waterfalls abound here. Just east of Peabody Lake, the North Sevogle passes through steep, rocky narrows in an impressive display of waterfalls and rapids. The Pallisades at the confluence of North Pole Stream and Little Southwest Miramichi River possess a myriad of small but thunderous waterfalls.

In 1989, Repap New Brunswick designated the Sheephouse Falls Nature Reserve along Sheephouse River, partly to recognize the locale's three picturesque waterfalls.

Lakes in this area are small and occur mainly in the western half of the terrain. They tend to overlie felsic volcanic rocks or granitic rocks, which are less porous than sedimentary strata and hence are more likely to retain water. One obvious example of the differential absorption can be seen at Mullin Lake, which is bound north and south by the bedrock contact between sedimentary and granitic rocks.

The transitional nature of the Tomogonops Ecodistrict is also evident in its climate. The ecodistrict is wedged between the cold, wet Highlands Ecoregion and the dry, relatively warm Eastern Lowlands. Its climate is a blend of the two, and is both moderately cool and wet.

Soils

The soil here is poor to only moderately fertile. The most common types are those of mixed igneous and metasedimentary derivation. Compact loams to sandy loams of the Long Lake Unit cover much of the southern section of the ecodistrict. Britt Brook Unit material is found on the lower slopes and valley bottoms, whereas Serpentine Unit soil usually frequents the upper slopes and crests. Soils of these units are coarse textured and droughty and are best tolerated by coniferous vegetation.

The least fertile and most acidic soils are those associated with areas underlain by felsic volcanic rocks. Soils of the shallow, stony Lomond Unit belong to this category, and cover hilltop sites in the extreme northwest part of the ecodistrict. Compact loams to sandy loams of the Popple Depot Unit are more prevalent along the middle to lower slopes, especially in the north.

Mafic volcanic rocks produce moderately fertile soils that are represented by the Kingston and Tetagouche units. The granitic gneiss around Mullin Lake has produced soils of the Tuadook Unit, which are fairly infertile and typically are associated with rolling hills.

Biota

The prevalence of acidic soil with low to moderate fertility has favoured a largely coniferous forest in this ecodistrict.

Acidic mid-slopes and flatlands (5, 2) have a high proportion of spruce-fir communities dominated by red spruce, balsam fir and black spruce. Dense balsam fir regeneration occurs in the west, notably north of Mullin Stream Lake where cool, moist climatic conditions resemble those of the adjacent Ganong Ecodistrict. Fir becomes less common along the steep dry slopes that line major valleys such as those of the Northwest Miramichi, Little Southwest Miramichi and Sevogle rivers.

A balsam fir forest along North Branch Big Sevogle River, upriver from Square Forks, is home to the silvery checkerspot butterfly.

Cedar and black spruce dominate the wet flatlands and gentle slopes (3, 6). A site located just north of the junction between Lower North Branch Little Southwest Miramichi and Little Southwest Miramichi River, for instance, supports large specimens of cedar and white spruce, accompanied by a rich diversity of plant understory species.

White pine occurs throughout the ecodistrict, especially in the west. Conversely, beech is relatively abundant in eastern areas, but diminishes toward the west. Tolerant hardwood forests tend to have sugar maple, yellow birch and beech, and are associated with well-drained, rolling hills. One of the more unusual hardwood stands is at Peabody Lake and contains scattered red oak, an unusual species for the area.

The intolerant hardwood community here is represented by white birch, trembling aspen and red maple with balsam fir and red spruce. Another mature forest lies 5 km west of Sheephouse Falls Reserve. It has an almost pure sugar maple with a thriving population of broad-lipped twayblade in terrain frequented by bear, moose, osprey and barred owl.

Several species of orchids (*Platanthera spp.*) grow on the floodplains along Big Sevogle River about 5 kilometers east of Peabody Lake. The peaty shores at the northwest end of Mullin Lake are a haven for a rare twig rush. Guagus Lake also harbours rare plants including creeping rush and lesser bladderwort. Several rivers and their tributaries in this ecodistrict contain salmon spawning grounds for the famous Miramichi salmon. Also in this ecodistrict are significant populations of resident and sea-run brook trout.

Settlement and Land Use

The Tomogonops Ecodistrict lies within the traditional Mi'kmaq territory of Gespegeog and adjoins Red Bank Ecodistrict, which has been settled by aboriginals for least the last 2800 years. People from the Red Bank villages used the Tomogonops Ecodistrict for hunting, fishing, and overland travel to northwest New Brunswick. The word *tomogonops* is Mi'kmaq for *pipestone*. Early aboriginals visited this ecodistrict to quarry local deposits of sericite schist, which they carved into pipes.

The first Europeans reached the Tomogonops Ecodistrict sometime in the early 1700s. By the early 1800s, lumbermen were swarming across its valleys, using the rivers to reach stands of pine and spruce. The frenzy abated somewhat after the 1825 Miramichi Fires razed the area, then resumed a few decades later to feed hungry shipyards and sawmills in nearby Chatham and Newcastle (now called the City of Miramichi).

The rocks here contain many mineral deposits, several of which were formerly developed. The most recently active operation was the Heath Steele Mine located between the north and south branches of

Tomogonops River. The mine worked sporadically from 1957, producing primarily base metals, and closed in October 1999.

The area's scenery and salmon-rich rivers have attracted visitors to canoe, fish, and hunt from the early 1800s to the present day. Several stretches of Crown Reserve Water allow many New Brunswickers access to high-quality salmon angling.

2.4. Tomogonops Ecodistrict at a Glance

Ecoregion: Northern Uplands

Area: 164, 938 ha

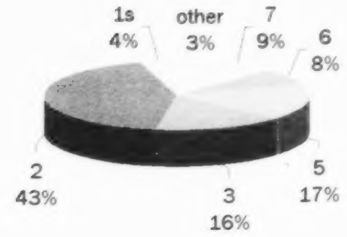
Average elevation above sea level: 357 m

Average May–September precipitation: 450 – 500 mm

Average annual degree-days above 5°C: 1400 – 1550

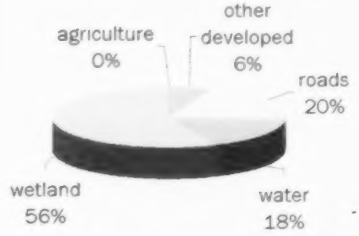
91% of Tomogonops Ecodistrict has forest cover

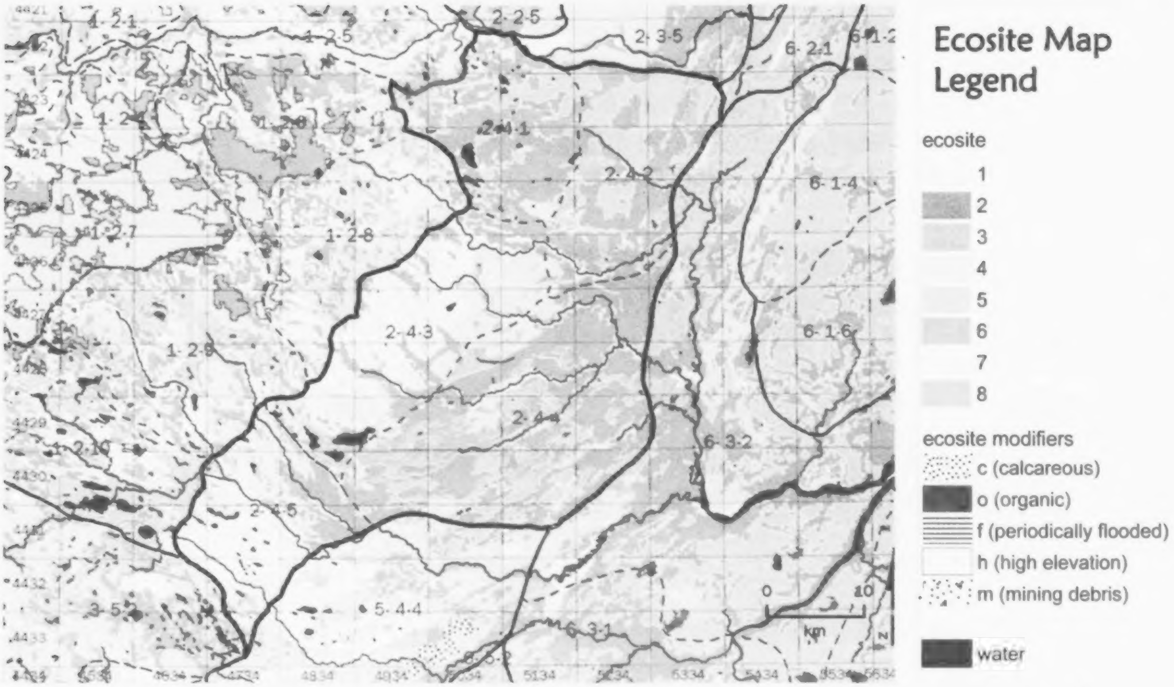
ecosite coverage of forest area



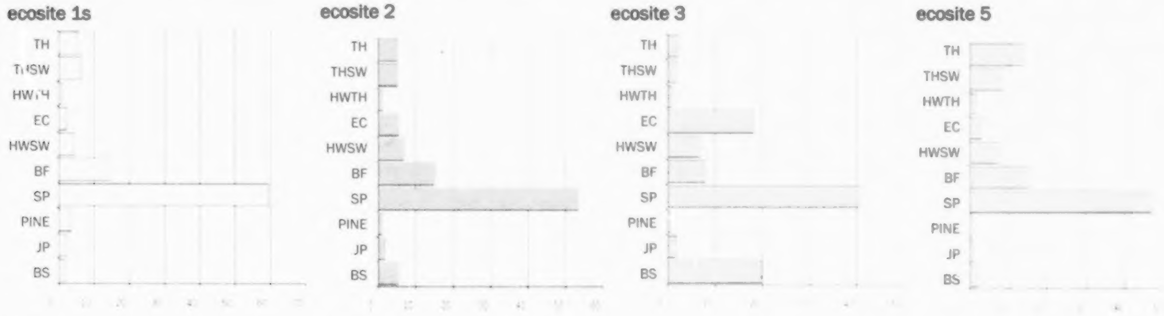
9% of Tomogonops Ecodistrict is not forested

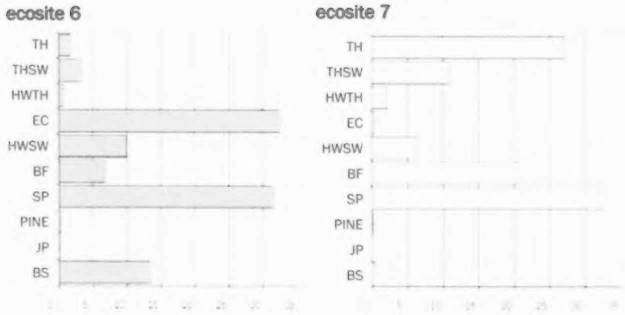
uses of non-forest area




Ecosite Map Legend
ecosite
1
2
3
4
5
6
7
8
ecosite modifiers
c (calcareous)
o (organic)
f (periodically flooded)
h (high elevation)
m (mining debris)
water
0
10
km
1-2-1
1-2-5
1-2-6
1-2-7
1-2-8
1-2-10
2-2-5
2-3-5
2-4-1
2-4-2
2-4-3
2-4-4
2-4-5
3-5
5-4-4
6-2-1
6-1-2
6-1-4
6-1-6
6-3-2
6-3-1
4434
4534
4634
4734
4834
4934
5034
5134
5234
5334
5434
5534
5634

Percent cover of forest stand types by ecosite

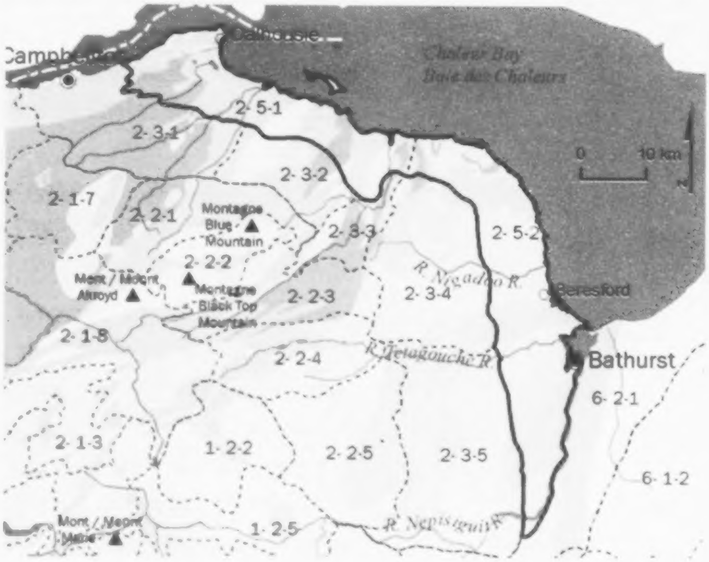




Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.

2.5. Nicolas Denys Ecodistrict

Nicolas Denys Ecodistrict is a narrow, gently sloping strip of land that lies along the coast of Chaleur Bay. It stretches from the Dalhousie Peninsula southward to the Nepisiguit River mouth, at which point the river itself becomes the boundary.


Campbellton
Dalhousie
Chaleur Bay
Baie des Chaleurs
0
10 km
2-5-1
2-3-1
2-3-2
2-1-7
2-2-1
Montagne Blue Mountain
2-3-3
2-5-2
2-2-2
Mont / Mount Alroyd
Montagne Black Top Mountain
2-2-3
R. Nigadoo R.
2-3-4
Beresford
2-1-8
2-2-4
R. Tetagouche R.
Bathurst
6-2-1
2-1-3
1-2-2
2-2-5
2-3-5
6-1-2
Mont / Mount Malle
1-2-5
R. Nepisiguit R.

Geology of Nicholas Denys Ecodistrict

Rock Types

Highly calcareous sedimentary

Calcareous sedimentary

Non-calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites

Geology

The bedrock in this ecodistrict can be separated into a northern section and a southern section, separated by a major fault that transects the ecodistrict from Beresford to Val-Michaud. A third, tiny zone called the Elmtree Inlier is enclosed within the northern section and contains its own distinct suite of rocks.

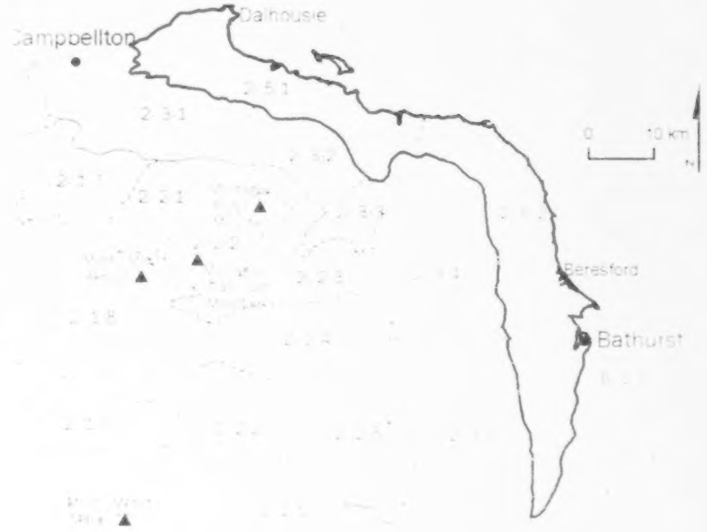
The southern section is characterized by Ordovician metasedimentary and mafic volcanics of the Tetagouche Group. The metasedimentary rocks include phyllite, slate and metaquartzite, whereas the mafic volcanics are primarily metabasalt. A large stock of Devonian red granite intrudes the metasedimentary rocks west of Nepisiguit River and south of Bathurst.

Lithologies are more diverse in the northern section. The bedrock is composed mainly of Silurian and Devonian mafic and felsic volcanic rocks accompanied by calcareous and non-calcareous sedimentary strata of both ages. Deposits of younger, Pennsylvanian sedimentary rocks overlie the older rocks in the vicinities of Eel River Crossing and Nash Creek, and in a narrow band south of Bathurst.

The Elmtree Inlier forms a roughly circular pattern near the Madran and Elmtree rivers and includes gabbro, peridotite, and metasedimentary rocks. The assemblage represents a remnant of oceanic crust that was upthrust over continental crust during a major Ordovician mountain-building event, which accompanied the closing of a proto-Atlantic Ocean.Some of the Silurian and Devonian sedimentary rocks are fossiliferous. A careful perusal of shorelines at Chapel Point near Belledune and Stewart's Cove

2.5. Nicolas Denys Ecodistrict

Nicolas Denys Ecodistrict is a narrow, gently sloping strip of land that lies along the coast of Chaleur Bay. It stretches from the Dalhousie Peninsula southward to the Nepisiguit River mouth, at which point the river itself becomes the boundary.


Dalhousie
Campbellton
2.5.1
2.3.1
0
10 km
Beresford
Bathurst

Geology of Nicolas Denys Ecodistrict

Rock Types
Highly calcareous sedimentary
Calcareous sedimentary
Non-calcareous sedimentary
Early Carboniferous sedimentary
Late Carboniferous sedimentary
Mafic volcanic
Felsic volcanic
Granites and granodiorites

Geology

The bedrock in this ecodistrict can be separated into a northern section and a southern section, separated by a major fault that transects the ecodistrict from Beresford to Val-Michaud. A third, tiny zone called the Elmtree Inlier is enclosed within the northern section and contains its own distinct suite of rocks.

The southern section is characterized by Ordovician metasedimentary and mafic volcanics of the Tetagouche Group. The metasedimentary rocks include phyllite, slate and metaquartzite, whereas the mafic volcanics are primarily metabasalt. A large stock of Devonian red granite intrudes the metasedimentary rocks west of Nepisiguit River and south of Bathurst.

Lithologies are more diverse in the northern section. The bedrock is composed mainly of Silurian and Devonian mafic and felsic volcanic rocks accompanied by calcareous and non-calcareous sedimentary strata of both ages. Deposits of younger, Pennsylvanian sedimentary rocks overlie the older rocks in the vicinities of Eel River Crossing and Nash Creek, and in a narrow band south of Bathurst.

The Elmtree Inlier forms a roughly circular pattern near the Madran and Elmtree rivers and includes gabbro, peridotite, and metasedimentary rocks. The assemblage represents a remnant of oceanic crust that was upthrust over continental crust during a major Ordovician mountain-building event, which accompanied the closing of a proto-Atlantic Ocean.Some of the Silurian and Devonian sedimentary rocks are fossiliferous. A careful perusal of shorelines at Chapel Point near Belledune and Stewart's Cove near Dalhousie will reveal corals, crinoids, gastropods, brachiopods and several other fossil specimens.

The red granite along Nepisiguit River was quarried irregularly from the 1860s to 1985 for material to erect some of the stone buildings in downtown Bathurst.

The Devonian volcanic rocks at Inch Arran Point near Dalhousie contain tiny vesicles that are filled with a range of unusual minerals including a white calcite that fluoresces bright pink under ultraviolet light.

The beach at Chapel Point contains sizeable pebbles of a pistachio-green mineral called epidote, some of which are suitable for polishing.

Landscape and Climate

Nicolas Denys Ecodistrict averages only 10 km wide and is the most subdued of all ecodistricts in the Northern Uplands Ecoregion. Its rock formations are similar to those of other ecodistricts, but are topographically much less dramatic than elsewhere in the ecoregion.

Elevations range from sea level or low coastal cliffs at Chaleur Bay up to a maximum height of about 150 m on the western boundary. Instead of highlands, there are several linear outcroppings including Black Brook Escarpment south of Dalhousie where a narrow resistant ridge of rock called diabase intrudes the landscape.

Many of the larger rivers have their exuberant origins elsewhere, but pass quietly through this ecodistrict to Chaleur Bay before discharging into a series of estuaries that teem with bird life. The Tetagouche, Jacquet, Nepisiguit, and Charlo rivers possess just enough energy to have moderately incised the landscape. In two instances —the South Charlo and Nepisiguit — they are decorated with waterfalls. Pabineau Falls on the Nepisiguit River south of Bathurst is one of the most beautiful features in the region and provides a popular recreation area for local residents and visitors.

Pabineau Falls, Nepisiguit River.

Lakes in the area are extremely

few. Pabineau Lake occurs south of Bathurst surrounded by relatively impermeable granitic bedrock. Mountain Brook Lake lies just west of Charlo and is blanketed on the bottom by one of the few marl deposits in New Brunswick. Marl is a soft, highly calcareous clay material that can occur as an unconsolidated layer in the bottom of lakes.

The climate here is relatively dry and cool, with temperature extremes that are moderated by Chaleur Bay.

Soils

The most fertile soils belong to the Carleton and Thibault units and comprise well-drained, medium- to fine-textured material derived from calcareous sedimentary rocks. These soils support the best quality tolerant hardwood stands.

Soils of moderate to good fertility can be found throughout the area and originate from three rock sources. Soils of the Holmesville Unit were derived from non-calcareous sedimentary rocks. Those of the Long Lake and Pinder units originated from a mixture of igneous and sedimentary lithologies. Areas of granitic and gabbroic bedrock coincide roughly with soils of the Tuadook and Kingston units.

Terrain underlain by felsic volcanic rocks weathers slowly to yield acidic soils of very low fertility. Well-drained soils of this type typify the Lomond and Jacquet River units and support forests of spruce, balsam fir, and white pine.

In addition to the above, small patches of marine glaciofluvial deposits occur adjacent to Chaleur Bay in areas underlain by Pennsylvanian sedimentary rocks. These range from the compact, fine-textured soils of the Tracadie Unit to the non-compact, coarse-textured soils of the Grand Falls Unit.

The more clay-rich, poorly drained soils of the Tracadie Unit tend to support cedar, tamarack, black spruce or, occasionally, black ash. Where well drained, they have been successfully cultivated for agricultural land.

Biota

The long history of human settlement has reduced the ecodistrict's formerly extensive coniferous forest cover to small patches of coniferous forests scattered in a predominantly mixed forest. The low, acidic flatlands (2) are now covered instead with a forest dominated by intolerant hardwoods such as trembling aspen, red maple, and white birch, with associated balsam fir, white spruce, and cedar representing the more tolerant coniferous climax community. The acidic slopes (5) tend to support mixed forests of balsam fir, red maple, and cedar accompanied by sugar maple and yellow birch.

Black spruce and cedar grow on broad valleys and flatlands that are moderately to poorly drained (6, 3). In fact, this ecodistrict has a high overall frequency of cedar, due to the prevalence of calcareous soils. Sugar maple, yellow birch, and beech are less common, and generally accompany conifers on calcareous slopes (5c, 7c).

One characteristic feature here is the estuaries, tidal flats and salt marshes that have developed where its rivers meet Chaleur Bay in a confluence of salt water and fresh water. These diverse and vulnerable sites contain many unusual or rare species of flora and fauna.

The Maritime ringlet butterfly is found in only a handful of locales in the world outside Nicolas Denys Ecodistrict. This species and its habitat are protected under legislation. Local salt marshes also host the more common salt-marsh copper, another endemic species of butterfly.

Rare plants in the southern part of Nicolas Denys Ecodistrict include the northern comandra and the lepidocarpate sedge. Eel River Cove is a local birding spot and hosts the one of the few known provincial occurrences of the rare plant white water crowfoot.

Visitors in nesting season can watch freshwater birds in the cove, then turn seaward for a different view: small craggy islands which, up close, are raucous with seabirds, osprey, and great blue heron.

The Maritime Ringlet butterfly. *Photograph courtesy of Reg Webster.*

Settlement and Land Use

The Nicolas Denys Ecodistrict lies within the traditional Mi'kmaq territory of Gespegeog. The early Mi'kmaq were primarily a maritime people who inhabited this coastal area where fish, crustaceans, seals, and seabirds provided ample food sources.

Archaeologists have found abundant evidence of early aboriginal activity along the shoreline and lower Nepisiguit River dating back at least 4000 years. The most important village was Oinpegitjoig in Bathurst Harbour. The Nepisiguit River not only supplied salmon, but also served as a major overland route to Saint John River and Maliseet territory via connecting portages. Sweet grass, a sweet-smelling grass that is considered sacred and is used ceremonially by aboriginal people, grows in several locales in the ecodistrict.

Despite pre-1500s visits from European fishermen and explorers, the first non-aboriginal settlement did not arise until the 1600s. Evidence suggests that Jesuits established a mission at Point au Père in 1620, a year before the pilgrims landed at Plymouth Rock. The famous trader and explorer Nicolas Denys was among the first non-aboriginal settlers in the ecodistrict. In 1668 he retired to a fortified red sandstone house in Bathurst Harbour to write a book about the geography and natural history of North America.

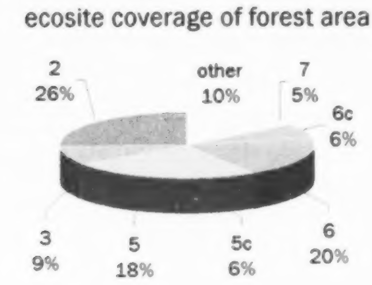
Fishing, fur trading, farming, shipbuilding and sawmills supported the area throughout the 1700s and 1800s, with Dalhousie and later Bathurst as the major economic centers. Both towns entered a new industrial era in the 1920s with the construction of pulp and paper mills. Dalhousie depends largely on its pulp and paper mill for employment. Bathurst's economic base includes mining, which began commercially with the development of the Brunswick lead-zinc deposits southwest Bathurst in the Tjigog Ecodistrict. The mine opened in the 1950s and operates in conjunction with the lead smelter at Belledune, another major regional employer. NB Power Thermal Generating Station is also located in Belledune and is a major employer in the region.

The Elmtree quarry located south of Madran produces limestone from remnants of an ancient coral reef complex that is about 400 million years old.

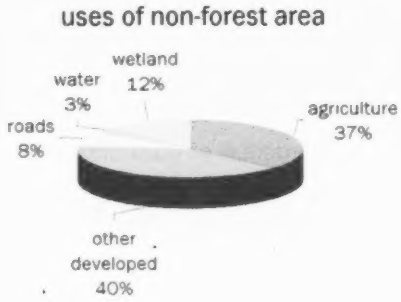
2.5. Nicholas Denys Ecodistrict at a Glance

Ecoregion: Northern Uplands
Area: 92, 443 ha
Average elevation above sea level: 72 m
Average May-September precipitation: 350–450 mm
Average annual degree-days above 5°C: 1400–1600

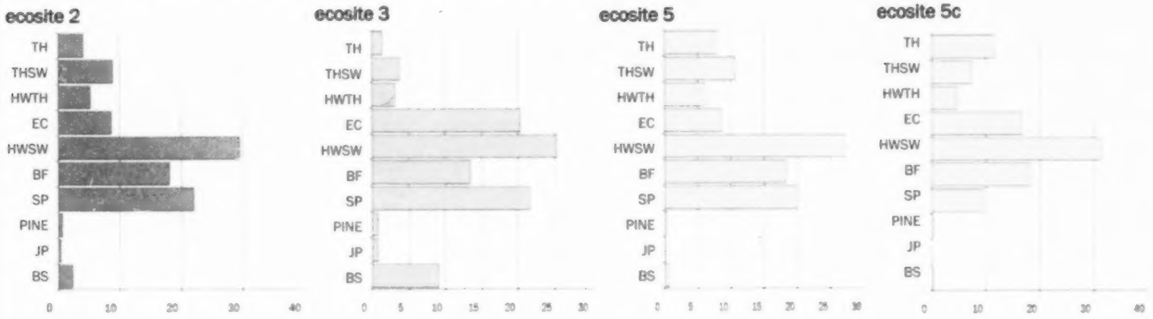
75% of Nicholas Denys Ecodistrict has forest cover

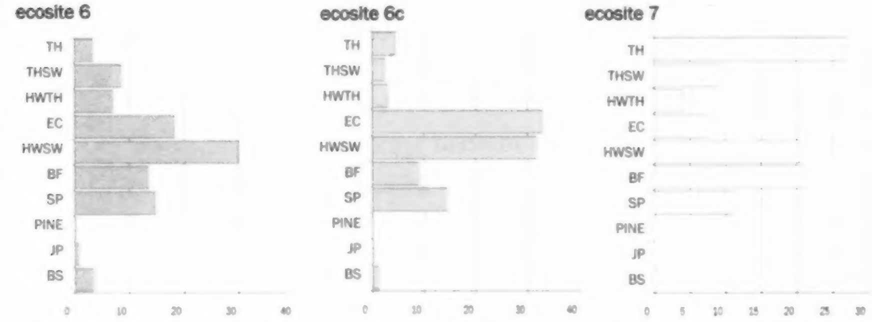


25% of Nicholas Denys Ecodistrict is not forested

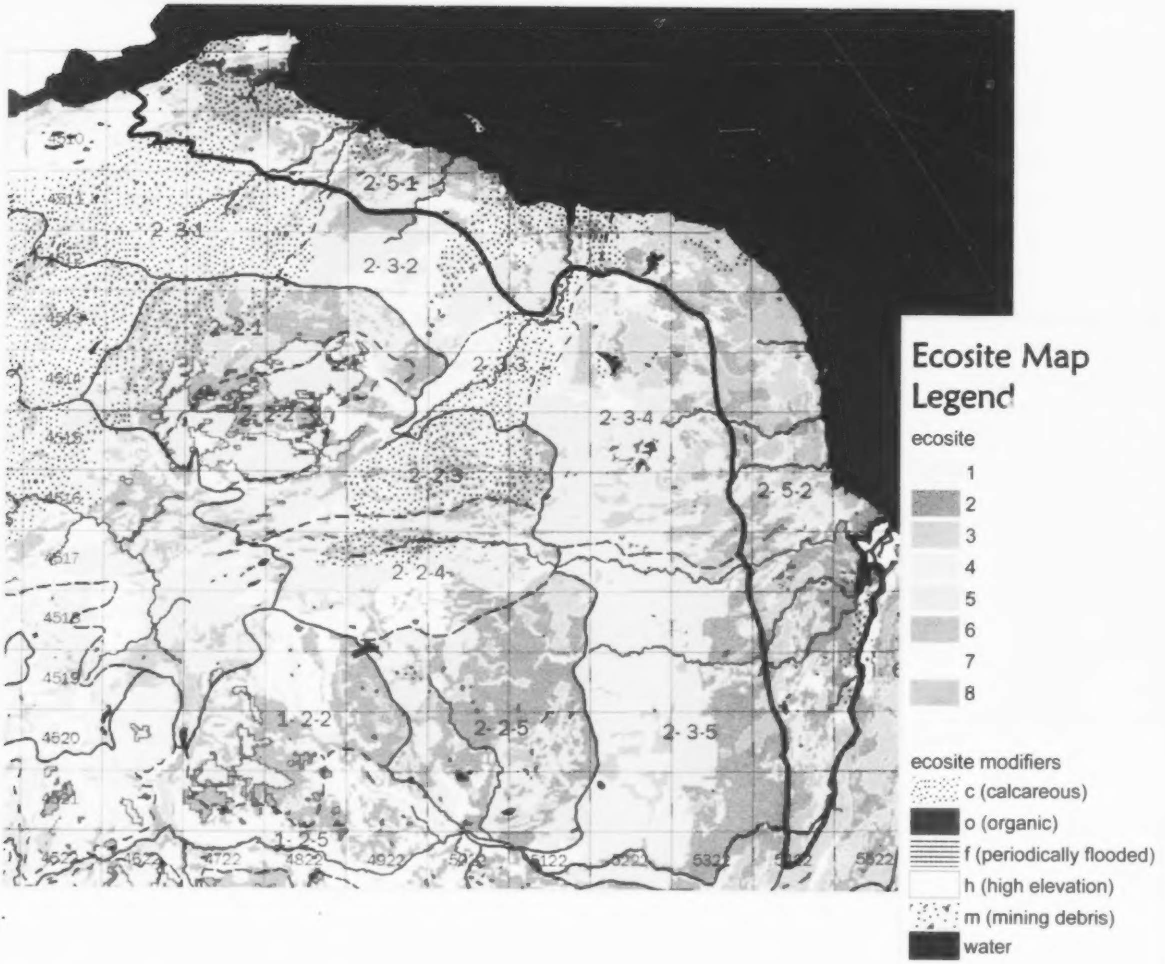


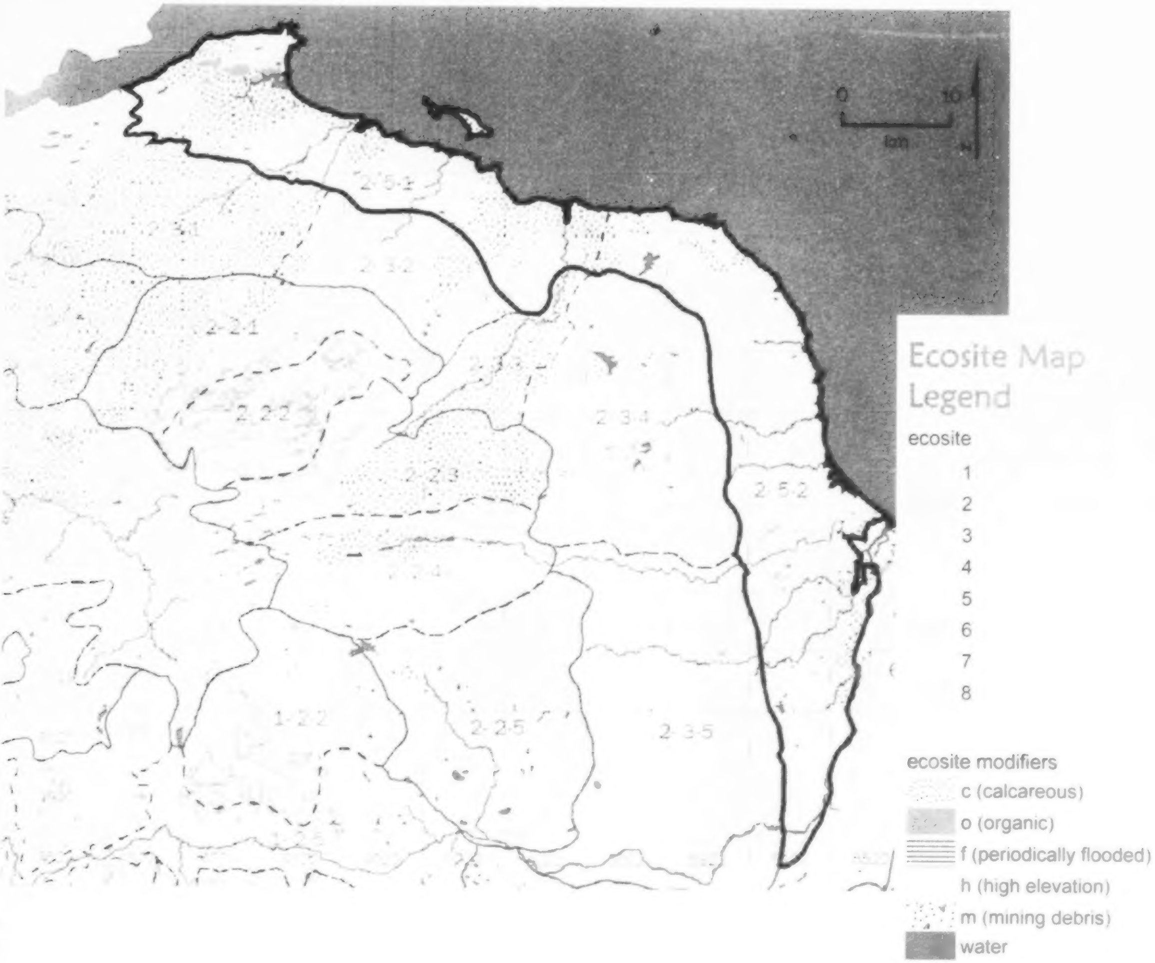
Percent cover of forest stand types by ecosite

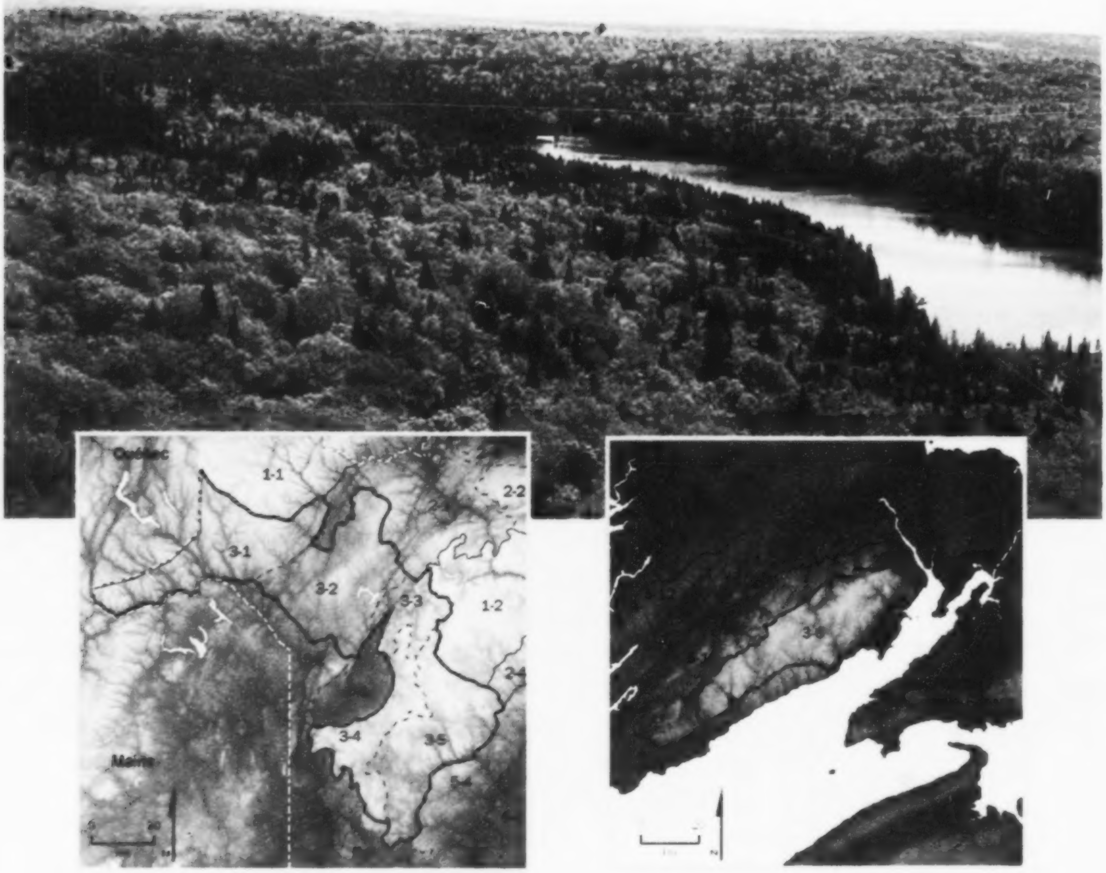




Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.


2-5-1
2-3-1
2-3-2
2-2-1
2-3-3
2-2-2
2-3-4
2-2-3
2-5-2
2-2-4
1-2-2
2-2-5
2-3-5
1-2-5
4510
4511
4512
4513
4514
4515
4516
4517
4518
4519
4520
4521
4722
4822
4922
5122
5222
5522
Ecosite Map Legend
ecosite
1
2
3
4
5
6
7
8
ecosite modifiers
c (calcareous)
o (organic)
f (periodically flooded)
h (high elevation)
m (mining debris)
water

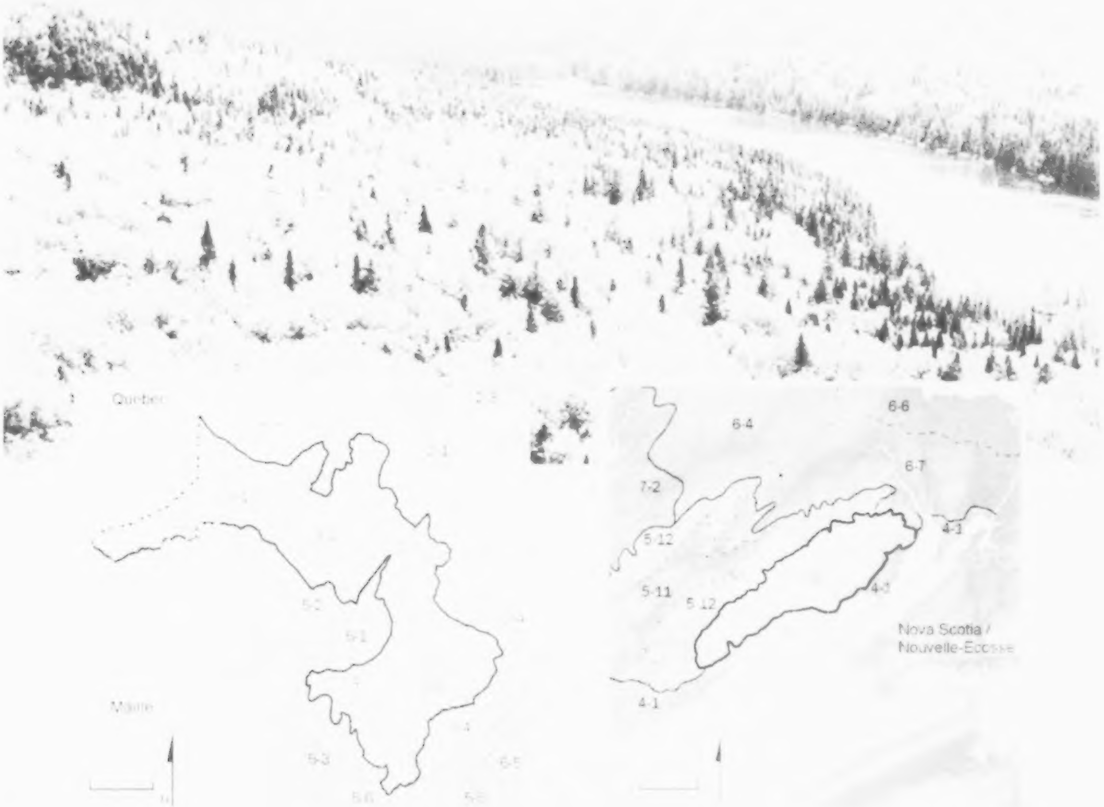

0
10
km
N
2-5-1
2-3-1
2-3-2
2-2-1
2-3-3
2-2-2
2-3-4
2-2-3
2-5-2
2-2-4
1-2-2
2-2-5
2-3-5
Ecosite Map Legend
ecosite
1
2
3
4
5
6
7
8
ecosite modifiers
c (calcareous)
o (organic)
f (periodically flooded)
h (high elevation)
m (mining debris)
water



Chapter 9

3. Central Uplands Ecoregion

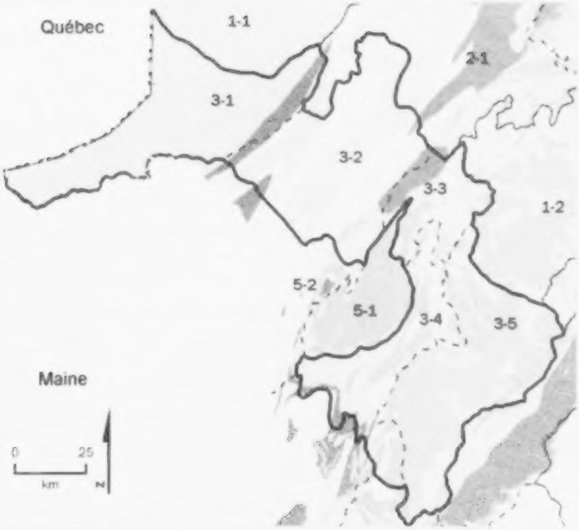
The Central Uplands Ecoregion consists of two separate upland areas: one in northwest New Brunswick and one in the southeast. The larger, Madawaska Uplands begins at the provincial panhandle and curves south towards upper York County. The smaller, Caledonia Uplands encompasses a broad plateau adjacent and parallel to the Bay of Fundy. Thus, the Central Uplands Ecoregion exemplifies how two geographically separated locations can have similar climates that in turn develop remarkably similar forest ecosystems.


Quebec
5-2
5-1
Maine
5-3
5-6
6-5
6-4
6-6
6-7
7-2
5-12
4-1
5-11
5-12
4-3
Nova Scotia / Nouvelle-Écosse
4-1

Chapter 9

3. Central Uplands Ecoregion

The Central Uplands Ecoregion consists of two separate upland areas: one in northwest New Brunswick and one in the southeast. The larger, Madawaska Uplands begins at the provincial panhandle and curves south towards upper York County. The smaller, Caledonia Uplands encompasses a broad plateau adjacent and parallel to the Bay of Fundy. Thus, the Central Uplands Ecoregion exemplifies how two geographically separated locations can have similar climates that in turn develop remarkably similar forest ecosystems.



Geology of the Madawaska Uplands, Central Uplands Ecoregion.

Rock Types

Highly calcareous sedimentary

Calcareous sedimentary

Non-calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

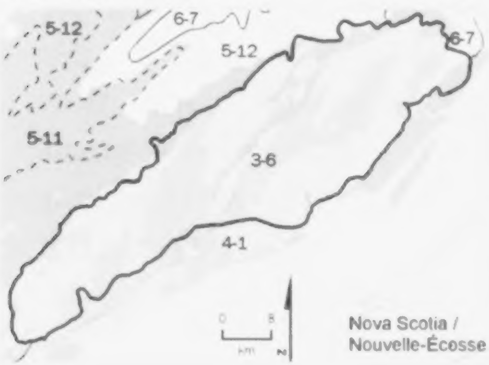
Granites and granodiorites

Geology and Landscape

Bedrock in the Madawaska Uplands can be broadly divided into two sections. The northern section contains steeply dipping Ordovician to Devonian metasedimentary rocks, some of which are calcareous. The southern section forms a plateau of Devonian granites with minor sedimentary and volcanic rocks of varied ages. The northern, sedimentary section is drained to the south and west by tributaries of the Saint John River that, in places, cut deeply through the vertically fractured bedrock. Rivers in the undulating, granitic southern area flow steadily eastward towards the Miramichi, often as not circumnavigating mountain ranges in the process. Lakes are more plentiful in the southern section, where the impermeable, less fractured granites result in lake formation. The landscape gradually diminishes in elevation from north to south, the result of differential tectonic uplift. The effect of this tilt is to provide dominantly south-facing slopes with slightly warmer topoclimates than otherwise would occur at this latitude. A number of mountains with diverse geologic origins – the granitic Quisibis Mountain and the volcanic Bald Peak, to name just two – create much scenic interest across the region.

The Caledonia Uplands consists almost entirely of Precambrian igneous bedrock with small but significant enclaves of much younger Carboniferous strata along the eastern boundary of the region. The ancient rocks form a massif with elevations surpassing 400 m and averaging about 300 m. What the area lacks in sizeable lakes, it makes up for in rivers with waterfalls. The plateau is flanked by steep, gorges whose waters plummet from the highlands down to either the Kennebecasis River, the Petitcodiac River, or the Bay of Fundy.

Geology of the Caledonia Uplands, Central Uplands Ecoregion.



Climate

Madawaska Uplands

The Madawaska Uplands sits at a higher elevation than the adjacent Valley Lowlands Ecoregion and hence has a cooler climate with relatively abundant

The hills visible in the far distance from a point in the Nackawic Ecodistrict shows the southern end of the Central Uplands Ecoregion rising above the Valley Lowlands Ecoregion.

precipitation. However, the mainly south- and west-facing aspect of the Madawaska landscape gives it warmer temperatures than those of the neighbouring Northern Uplands Ecoregion, whose dominant aspect faces north. Unlike the Valley Lowlands and Northern Uplands ecoregions, this area does not lie in a rain shadow. Precipitation amounts are fairly high due to the effects of orographic lifting across the undulating terrain.

Caledonia Uplands

The Caledonia Uplands also has a cool and wet climate, reflecting its high elevation and the moderating effect of the Bay of Fundy. The elevation enables it to partly avoid the cool oceanic air; its summer temperatures thus are warmer than along the Fundy coast. On the other hand, the Caledonia Uplands intercept the moisture-laden sea air and so are subject to high precipitation. Both here and in the Madawaska Uplands, abundant rainfall has created an historically low frequency of forest fires, which has reduced the occurrence of fire-dependent tree species.

The Caledonia Uplands are seen here rising above the Fundy Coast Ecoregion near Riverside Albert.

Forest Cover

Unlike forests in the cooler Northern Uplands and Highlands ecoregions, those in the somewhat warmer Central Uplands Ecoregion are not dominated by northern coniferous species. Instead, trees with southern affinities are widespread across the terrain. The effects of daily drainage of cold air from the tops of landforms into the valleys are readily seen in the distribution of hardwoods and softwoods. The lower slopes and valleys consequently support coniferous communities of balsam fir and spruce; red, white, and black spruce are common. Mixed forests of balsam fir, spruce, and tolerant hardwoods can be found on steep slopes, whereas hardwood stands prefer the upper slopes, ridges, and hilltops.

The broadly southern aspect of the Madawaska Uplands with its associated warmer topoclimate favours the development of tolerant hardwood forests. By contrast, the tolerant hardwood communities in the Caledonia Uplands often occur on slopes that face north and northeast. This likely is in response to the prevailing winds off the Bay of Fundy: salt-bearing, cool breezes that arrive from the south and southwest. Stands of yellow birch, sugar maple, and beech occur throughout the ecoregion and appear in autumn as vibrant quilts over the rolling terrain. Beech tends to be more predominant on acidic soils or on shallow-soils-to-bedrock sites, whereas sugar maple and yellow birch are more predominant on calcareous sites. The areas underlain by sedimentary rock in the Madawaska Uplands contain the province's highest concentration of these three hardwood species. Coniferous and mixed-stand conditions prevail on granitic soils.

Hobblebush is a medium to tall shrub common in the Central Uplands Ecoregion.

Cedar occurs in swamps alongside spruce and balsam fir and is abundant on calcareous soils along the Little Main Restigouche and Grand River watersheds. This species, however, appears rarely in the Caledonia Uplands. Tree species at the northern limit of their range such as red oak, ironwood, basswood, butternut, white ash, green ash, and hemlock can be found in scattered locations with warmer-than-average conditions. The low frequency of wildfires has restricted the growth of fire-dependent trees such as trembling aspen and the pines. Cool soil temperatures may also negatively affect root-suckering of poplar. The region's hardwood and mixed-forest stands display a well developed understorey vegetation of mountain maple, striped maple, and hobblebush, the last of which is characteristic of the area. Mountain fern moss is found in both coniferous and deciduous forests, and wood sorrel occurs abundantly, as does wood fern and shining clubmoss. Conversely, blueberry, sheep laurel, and wintergreen are uncommon here, being more typical of the drier ecoregions and poor soils. A unique assemblage of disjunct arctic plant species hugs the face of a gypsum cliff in the Caledonia Uplands, but this is hardly characteristic of the region (see Caledonia Ecodistrict). Similarly, calcareous cliffs of the Sisson Gorge are outposts for some rare northern plant species.

Wetlands

The steep terrain of the northern Madawaska Uplands limits the area of wetlands. The most common wetland types in ecodistricts of this area are alder swamps alongside streams, and shallow open water communities or marshes bracketing lakes. Farther south, wetlands become more diverse and prevalent in areas of granitic rock and where glacial till has impeded drainage. Several extensive peatlands occur in the area, including the impressive Juniper Barren (see Beadle Ecodistrict).

The Caledonia Uplands, with its dominantly igneous bedrock, contains a small but varied assortment of wetland types including peatlands, streamside alder swamps, marshes, and shallow open water communities. Peatlands are somewhat more prevalent in the western portion and may include some coastal elements, whereas marshes become more common along the eastern edge of the region.

3.1. Madawaska Ecodistrict

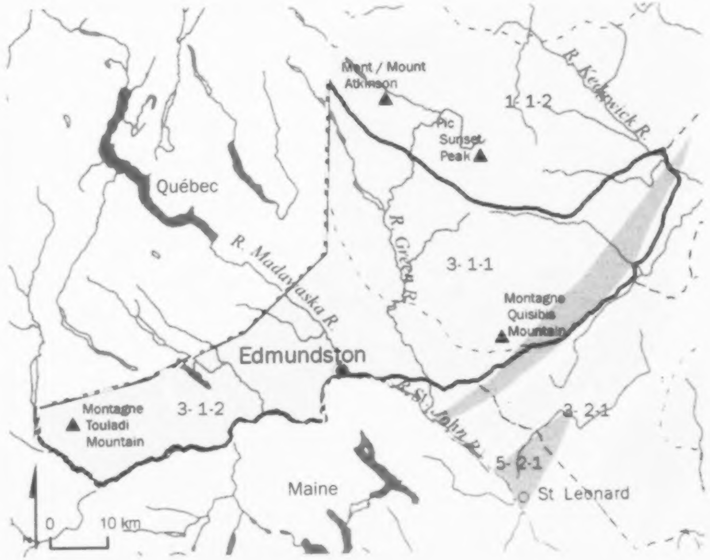
The Madawaska Ecodistrict is a hilly area in northwestern New Brunswick that includes the westernmost extension of the province, sometimes called the 'panhandle.'

Geology

The oldest rocks here are represented by a narrow sliver of Silurian slate and sandstone that roughly parallels the southeast border of the ecodistrict. The remainder of the ecodistrict is underlain by Devonian slate, siltstone, and greywacke of the Temiscouata Formation. Several small but resistant bodies of Devonian granite intrude metasedimentary rocks in the vicinity of the town of Green River (Rivière Verte). They are expressed topographically as Quisibis Mountain and Green River Mountain (or Monteigne-des-Therriens).

Geology of Madawaska Ecodistrict

Rock Types


Highly calcareous sedimentary
Calcareous sedimentary
Non-calcareous sedimentary
Early Carboniferous sedimentary
Late Carboniferous sedimentary
Mafic volcanic
Felsic volcanic
Granites and granodiorites
Mont / Mount Atkinson
1-1-2
R. Kedgwick R.
Pic Sunset Peak
Québec
R. Madawaska R.
R. Green R.
3-1-1
Montagne Quisibis Mountain
Edmundston
R. St John R.
Montagne Touladi Mountain
3-1-2
3-2-1
5-2-1
Maine
St Leonard
0
10 km

The Silurian and Devonian metasedimentary strata have been compressed into tight, upright folds with many vertical fractures, giving outcrops a typically shattered appearance. The regional pattern of bedrock lineations subsequently affected pathways of glacial ice, which in turn influenced the direction and drainage patterns of rivers and lakes.

A deposit of the rare mineral vivianite occurs near Saint-

Jacques along the Trout River. This brilliant green or blue mineral is composed of iron and phosphate.

Landscape and Climate

The landscape in this ecodistrict is defined by its rivers. The Green River bisects the terrain, meandering at first through a chain of lakes before gathering enough force to hurtle downslope into the Saint John River. The Saint John and St. Francis rivers delineate the south and west ecodistrict boundaries, respectively. The Madawaska River divides the panhandle from the rest of the ecodistrict before entering the Saint John River at Edmundston. Farther north, the Restigouche River arises from its highland source and moves southeast as though to join the Saint John River, but then abruptly alters course to head for Chaleur Bay.

Many of the rivers - especially the Little Main Restigouche, the middle reaches of the Green, the Madawaska and the St. Francis - have incised the landscape deeply into gorges and canyons. The resulting terrain is one of steep valleys with a relief of 150 m to 210 m separated by broad ridges approaching 500 m.

Moving from northeast to southwest across the ecodistrict, the elevation drops steadily from a height of about 510 m along the border abutting the Kejwik Ecodistrict down to a level of about 150 m at the confluence of the Saint John and Madawaska rivers. Crossing to the panhandle, the landscape rises to about 400 m and then descends again at the St. Francis River and Maine border to about 150 m. The 528 m summit of Touladi Mountain at the tip of the panhandle is the highest point of land in the ecodistrict.

The most prominent lakes are Glasier and Baker lakes on the panhandle, and First, Second, and Third lakes, which flow into the Green River, paralleling the northwest-southeast orientation of landforms in the area.

The relatively high elevations here have resulted in a climate of cool temperatures and abundant rainfall that is only slightly less than that in the adjacent, even higher, Kejwik Ecodistrict.

Soils

The dominant soils are derived primarily from non-calcareous slate, siltstone, and greywacke that weather slowly to yield a moderately acidic soil. Locally, the rocks are calcareous and suitable for boosting forest productivity. The most prevalent soils are compact tills of the Holmesville Unit, with its silty loams derived from underlying bedrock. Soils of the shallow, stony Glassville Unit occur on some ridgetops, whereas tills of the gravelly, water-reworked McGee Unit are found along middle to lower slope positions.

Coarse-textured glaciofluvial deposits of the Grand Falls Unit line the valley bottoms and lower slopes along the Green, Madawaska, and Little Main Restigouche rivers. Alluvial deposits, often capped with silt or fine sand of the Interval Unit, are common along the Saint John River and lower stretches of the Madawaska and Green river valleys.

Biota

The ecodistrict is dominated by broad, acidic bedrock ridges (8) capped by hardwood stands of sugar maple, yellow birch, and beech with scattered balsam fir, red spruce, and white spruce. On acidic mid-slopes at higher elevations (7), the proportion of conifers increases to form a more mixed forest.

Softwood communities occur more frequently along the mid-slopes and steep lower slopes (5, 4). The lower slopes and valley bottoms are covered with balsam fir, white spruce, and red spruce on both dry and moist sites (1, 2), whereas black spruce and cedar prefer wetter sites (3, 6). Balsam poplar, American elm, and trembling aspen grow on seasonally flooded soils along rivers. The intolerant hardwood community here is an early successional stage of the coniferous-dominated community and is characterized by trembling aspen, white birch, and red maple with an understorey of balsam fir and white spruce.

The Madawaska River, and a typical mixed forest. Just a few kilometres to the north is the Québec border.

McCoy Brook Ecological Reserve protects one of the few remaining old-growth mixed forests in this ecodistrict and contains mature sugar maple, beech, and yellow birch. Glasier Lake Ecological Reserve in the ecodistrict has a similar forest community.

Loon Lake north of Third Lake is a richly diverse, boggy site with several rare plants including mountain valerian, and livid sedge. Mosses near the lake also shelter a tiny population of small round-leaved orchis, a species that has vanished from much of the northeastern United States.

Settlement and Land Use

The Madawaska Ecodistrict lies within the traditional Maliseet territory. The Maliseet or their ancestors lived, hunted, and fished here for at least 9000 years before European contact. The most important native settlement in the ecodistrict lay at the confluence of the Madawaska and Saint John rivers. The Madawaska formed a crucial link in a portage between the Saint John and St. Lawrence rivers via Lake Temiscouata and Rivière-du-Loup. Maliseet travelling in spring were able to canoe and portage the 720 km from Saint John to Québec City in five days.

In 1786-87, Acadians from the lower Saint John River valley became the first non-aboriginals to inhabit the area, settling around the native village at the Madawaska River. Over the next seventy years, the community became embroiled in a series of territorial claims between the United States, Britain, and Québec. The British-American disputes culminated in the late 1830s with the Aroostook War, which was waged more in local pubs than in the field. No one perished in battle during the war, but a bullet fired from a festive rifle during the end-of-war celebrations accidentally killed one man.

Local timber exploitation began in the late 1700s, faltered during the border disputes, then renewed again when matters became settled after 1842. By the 1850s, logging and farming were economic mainstays of the area, and Edmundston served as the trading centre for lumber merchants. The arrival of the railway in the late 1870s provided further impetus to an already thriving timber industry.

The ecodistrict's modern settlement pattern shows concentrations along major river valleys and lake margins; Edmundston is the most populated centre. Forest tracts in this ecodistrict are divided between industrial freehold land, small private woodlots, and Crown land.

Mixed farming occurs over about 4% of the ecodistrict and consists mainly of forage, grain, and pasture production with some hog and poultry operations. Maple syrup is produced commercially.

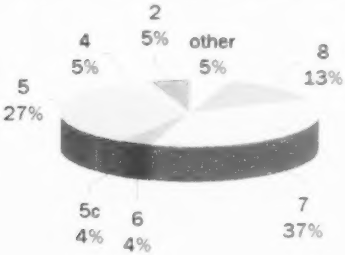
A view of Edmundston, where the Madawaska and Saint John Rivers meet. *Photograph © Ron Garnett–AirScapes.ca*

3.1. Madawaska Ecodistrict at a Glance

Ecoregion: Central Uplands
Area: 265,047 ha
Average elevation above sea level: 323 m
Average May—September precipitation: 475—525 mm
Average annual degree-days above 5°C: 1400—1600

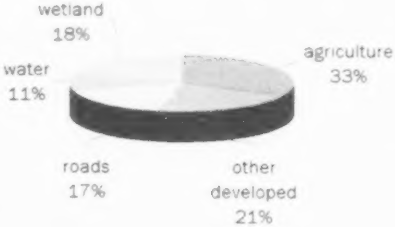
90% of Madawaska Ecodistrict has forest cover

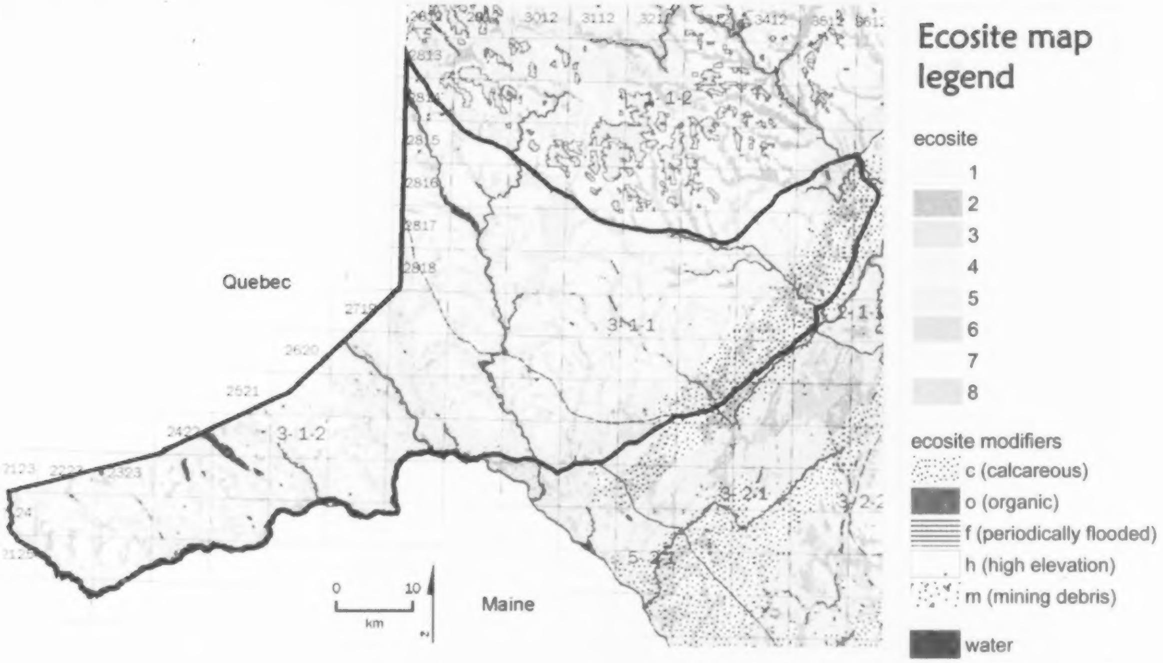
ecosite coverage of forest area



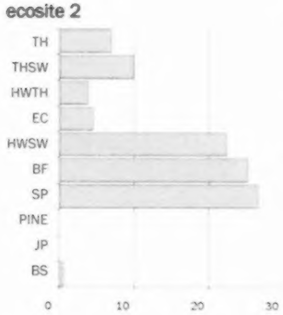
10% of Madawaska Ecodistrict is not forested

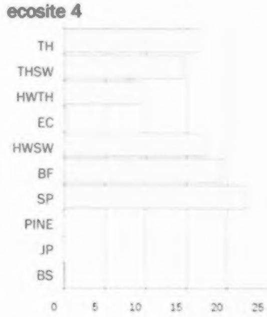
uses of non-forest area

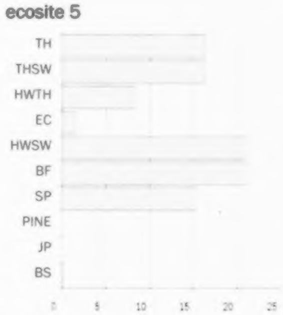


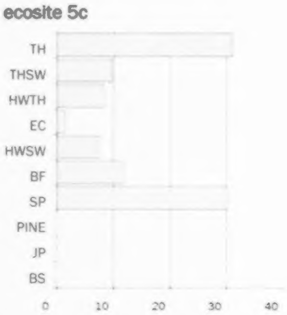

Ecosite map legend
ecosite
1
2
3
4
5
6
7
8
ecosite modifiers
c (calcareous)
o (organic)
f (periodically flooded)
h (high elevation)
m (mining debris)
water
Quebec
Maine
3-1-1
3-1-2
3-2-1
5-2-1
0
10
km
3012
3112
3412
2813
2815
2816
2817
2818
2719
2620
2521
2422
2323
2223
2123
2125

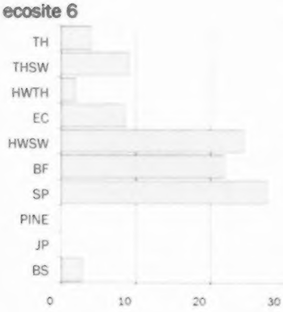
Percent cover of forest stand types by ecosite

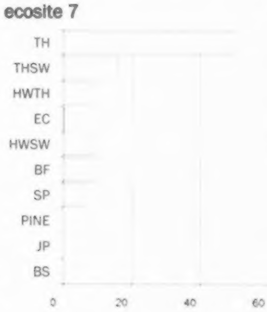


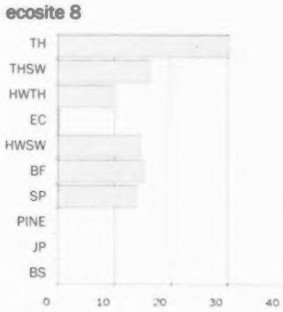












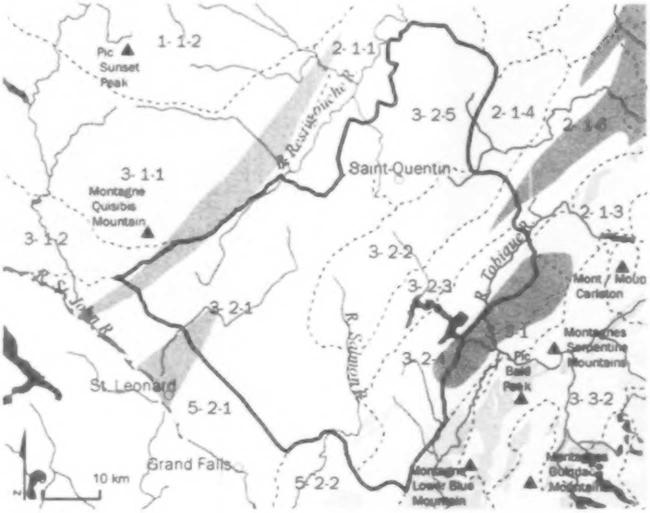
Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.

3.2. Sisson Ecodistrict

The Sisson Ecodistrict is an undulating plateau in northwestern New Brunswick, wedged between highlands of the Northern Uplands Ecoregion and broad valleys of the Valley Lowlands Ecoregion.

Geology

The bedrock of this ecodistrict is composed mainly of Ordovician–Devonian sedimentary strata that occur as narrow, northeast-trending belts across the ecodistrict. The belts alternate between the less calcareous, resistant rocks of the Ordovician Grog Brook Group and the calcareous, easily eroded rocks of the Ordovician–Silurian Matapedia Group.


1-1-2
Pic Sunset Peak
2-1-1
R. Restigouche R.
3-2-5
2-1-4
2-1-6
Saint-Quentin
3-1-1
Montagne Quisibis Mountain
2-1-3
3-1-2
3-2-2
R. St. John R.
3-2-3
R. Tobique R.
Mont / Mount Carleton
3-2-1
R. Salmon R.
3-3-1
Montagnes Serpentine Mountains
3-2-4
Pic Bald Peak
St. Leonard
5-2-1
3-3-2
Grand Falls
10 km
5-2-2
Montagne Lower Blue Mountain
Montagnes Gulquac Mountains

Geology of Sisson Ecodistrict

Rock Types

Highly calcareous sedimentary

Calcareous sedimentary

Non-calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites

Lithologies of the Grog Brook Group comprise slate, argillite, siltstone, and sandstone; those of the Matapedia Group are limestone, calcareous shale, and sandstone. A narrow band of Devonian calcareous and non-calcareous metasedimentary rocks from the Temiscouata Formation occurs in the southeast extremity of the ecodistrict immediately adjacent to the Sisson Branch Reservoir.

Several faults have transected the area and created natural conduits for streams and rivers. The largest is the Restigouche Fault, which enters at Jardine Brook in the north, then continues southward along the brook to meet and follow the Little River farther south. Part of the Little Tobique River follows an ancient fault contact between rocks of the Matapedia Group and the Temiscouata Formation. The fault along the Little Tobique River has created an escarpment known as Gesner Ridge and was named after New Brunswick's first provincial geologist, Abraham Gesner.

Landscape and Climate

The topography mirrors the underlying geology of alternating resistant and non-resistant rocks. Differential erosion has created an undulating landscape. From northwest to southeast it consists of a fairly high, resistant plateau along the western margin; a lower, calcareous area running between Saint-Quentin and Saint-Leonard;

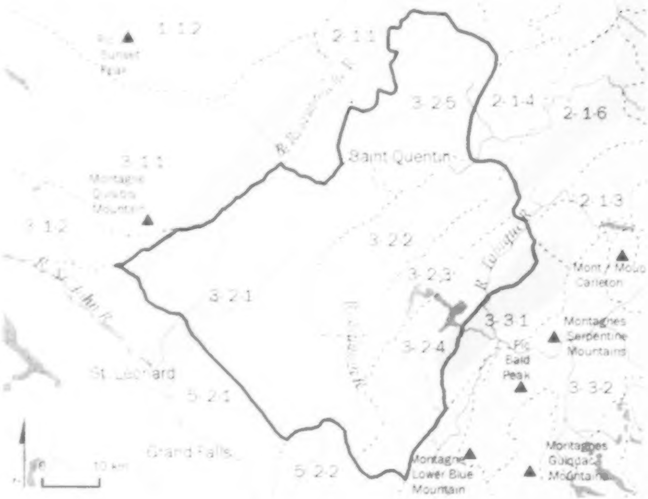
3.2. Sisson Ecodistrict

The Sisson Ecodistrict is an undulating plateau in northwestern New Brunswick, wedged between highlands of the Northern Uplands Ecoregion and broad valleys of the Valley Lowlands Ecoregion.

Geology

The bedrock of this ecodistrict is composed mainly of Ordovician-Devonian sedimentary strata that occur as narrow, northeast-trending belts across the ecodistrict. The belts alternate between the less calcareous, resistant rocks of the Ordovician Grog Brook Group and the calcareous, easily eroded rocks of the Ordovician-Silurian Matapedia Group.

Lithologies of the Grog Brook Group comprise slate, argillite, siltstone, and sandstone; those of the Matapedia Group are limestone, calcareous shale, and sandstone. A narrow band of Devonian calcareous and non-calcareous metasedimentary rocks from the Temiscouata Formation occurs in the southeast extremity of the ecodistrict immediately adjacent to the Sisson Branch Reservoir.


1-1-2
Pic Sunset Peak
2-1-1
3-2-5
2-1-4
2-1-6
Saint-Quentin
3-1-1
Montagne Quisibis Mountain
3-1-2
R. Saint-John R.
R. Tobique R.
2-1-3
3-2-2
Mont / Mount Carleton
3-2-3
3-2-1
3-3-1
Montagnes Serpentine Mountains
3-2-4
Pic Bald Peak
St. Leonard
5-2-1
3-3-2
10 km
Grand Falls
5-2-2
Montagne Lower Blue Mountain
Montagnes Guiqdac Mountains

Geology of Sisson Ecodistrict

Rock Types

Highly calcareous sedimentary

Calcareous sedimentary

Non-calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites

Several faults have transected the area and created natural conduits for streams and rivers. The largest is the Restigouche Fault, which enters at Jardine Brook in the north, then continues southward along the brook to meet and follow the Little River farther south. Part of the Little Tobique River follows an ancient fault contact between rocks of the Matapedia Group and the Temiscouata Formation. The fault along the Little Tobique River has created an escarpment known as Gesner Ridge and was named after New Brunswick's first provincial geologist, Abraham Gesner.

Landscape and Climate

The topography mirrors the underlying geology of alternating resistant and non-resistant rocks. Differential erosion has created an undulating landscape. From northwest to southeast it consists of a fairly high, resistant plateau along the western margin; a lower, calcareous area running between Saint-Quentin and Saint-Leonard;

an even higher plateau just northeast of Sisson Branch Reservoir; a lower area around the reservoir; and a small plateau along the eastern margin.

In the areas of non-calcareous, resistant terrain, streams tend to race straight downhill through zones of bedrock weakness, sometimes creating incised gorges with 200 m drops. The Little Main Restigouche River is flanked by several fog-wrapped gulches whose precipitous slopes have discouraged logging. The softer calcareous bedrock enables rivers to meander more freely, eroding the riverbanks into classic oxbow formations such as appear in the lower reaches of the Grand River.

The differential erosion of calcareous and non-calcareous rocks is also evident in the choice of local transportation routes. Both Highway 17 and the railroad were constructed over a soft zone of calcareous bedrock, sandwiched between two adjacent ridges of more rugged terrain.

The largest 'lake' in the ecodistrict is the Sisson Branch Reservoir that was created in 1953 by a hydroelectric dam on Sisson Branch. Farther north is St. Quentin Lake, one of the few marl-bottomed lakes in the province.

As with other ecodistricts in the Central Uplands Ecoregion, the relatively high elevations have given the Sisson Ecodistrict a moderately cool and wet climate.

Soils

Deep, loamy soils of the Caribou Unit predominate in areas of low relief. They are derived from soft, argillaceous limestone and are characterized by friable fragments of siltstone, from which the calcite matrix has been weathered.

These highly fertile soils support fine-quality stands of sugar maple and yellow birch when well drained, or white spruce and balsam fir when poorly drained. Caribou soils also underlie the vigorous growths of raspberries, mountain maple, and beaked hazel that follow timber harvest. Compact soils rich in silt and clay represent the Holmesville and Siegas units and are common in areas of low relief in the west. Higher terrain is dominated by the shallow, slightly less fertile, stony to moderately stony soils of the Glassville and Thibault units.

Glaciofluvial deposits of the Grand Falls and Muniac units line the Little Tobique River and are found locally along the Salmon and Grand rivers. These gravelly, coarse-textured soils support a mainly coniferous vegetation.

Biota

The vegetation assemblages here somewhat resemble those of the adjoining Madawaska Ecodistrict. Sisson Ecodistrict, however, possesses fewer stands of tolerant hardwood and more of coniferous and mixed forest, a consequence of having more areas with lower relief and impeded soil drainage.

Harrison Brook Ridge northeast of Ste-Anne-de-Madawaska displays a typical ridgetop hardwood forest melding into a downslope mixed forest. It also has a small, disjunct population of hemlock. The well drained ridges in acidic or calcareous terrain (8, 8l) support tolerant hardwood stands composed of sugar maple, yellow birch, and beech, which grade into mixed-forest stands dominated by yellow birch and spruce on the upper slopes (7, 7l).

Forests of balsam fir with white spruce, red spruce, and some black spruce are associated with steep calcareous slopes and broad valleys (5, 2c). The early successional community of intolerant hardwoods occurs on regenerating harvest blocks and consists of trembling aspen with white birch and red maple mixed with balsam fir, white spruce, and red spruce. Areas with calcareous but poorly drained soils (6c, 6l) support cedar with balsam fir and black spruce.

Pockets of calcareous, high-acidity soils in this ecodistrict support a remarkable diversity of understorey species. At Lynch Brook northeast of Saint-Léonard, a cedar swamp with large trees occurs alongside a population of rare northern bog aster. The deep cliff faces of Sisson Gorge just below the reservoir dam represent an enclave of calcareous-loving vegetation. The site nestles between outcrops and shelters several extremely rare plants; the most notable of these are elegant sedge, glaucous meadow-grass, and seep leopardbane.

The Sisson Branch Reservoir has been a refuge for breeding great blue heron and osprey. A much smaller, artificial pond on the western margin of the ecodistrict, Siegas Lake, hosts avian visitors including American black duck, blue-winged teal, and common merganser.

Settlement and Land Use

Sisson Ecodistrict lies within traditional Maliseet territory. Aboriginals living in the Saint John River valley visited this area to hunt for game and to travel across country via portages between the

Saint John, Restigouche, and Nepisiguit rivers. The water route between the Saint John and Restigouche rivers involved canoeing up the Grand River to Wagan Brook, then portaging across to Wagansis Brook, which winds into the Restigouche River.

The Tobique and Restigouche rivers and their tributaries were logged throughout the 1800s. Permanent, non-native settlement within the ecodistrict did not begin until after the 1910 completion of the International Railway between Saint-Léonard and Campbellton. The railroad and, later, the highway opened the ecodistrict's interior, encouraging the establishment of villages such as Kedgwick and Saint-Quentin along the line and facilitating the removal of timber to regional sawmills and pulp operations.

Although the ecodistrict's more fertile soils have good agricultural potential, what little land has been cleared is used primarily for mixed farming dominated by potato production. Several gold showings have been found in brooks east of Saint-Quentin, but the area has never seen a commercial mining venture. Forest tracts in this ecodistrict are divided between industrial freehold land, small private woodlots, and Crown land. The local economy relies mainly on forestry operations, agriculture, hunting, fishing, and tourism.

The gentle relief, good soil texture and acid neutralizing tendency of lands underlain by calcareous rocks help farmers near Saint-Martin-de-Restigouche to cope with a relatively short growing season. Forests in the ecodistrict are also of above average productivity, owing to good soil characteristics and to abundant rainfall in a typical year. *Photograph © Airscapes, used with permission.*

3.2. Sisson Ecodistrict at a Glance

Ecoregion: Central Uplands

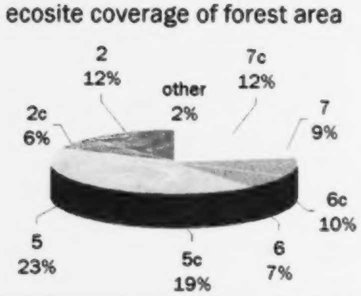
Area: 280, 947 ha

Average elevation above sea level: 295 m

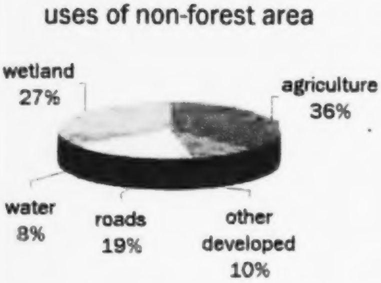
Average May–September precipitation: 450–500 mm

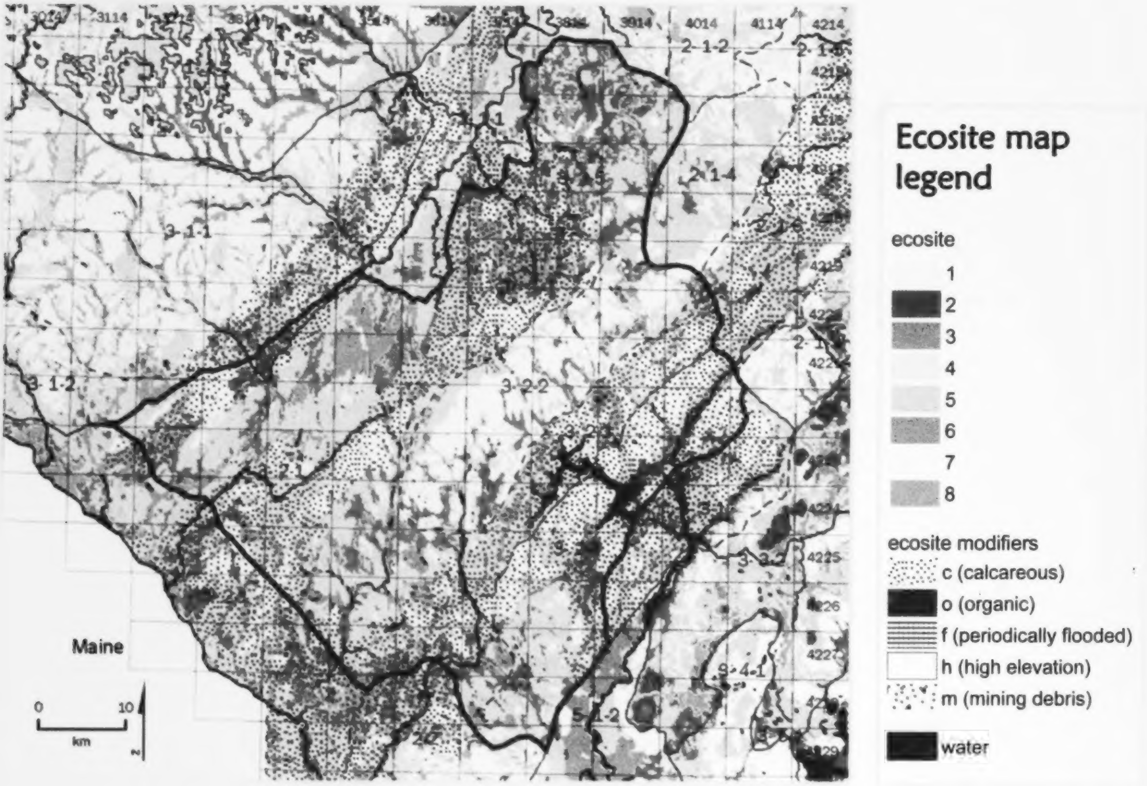
Average annual degree-days above 5°C: 1400–1550

90% of Sisson Ecodistrict has forest cover

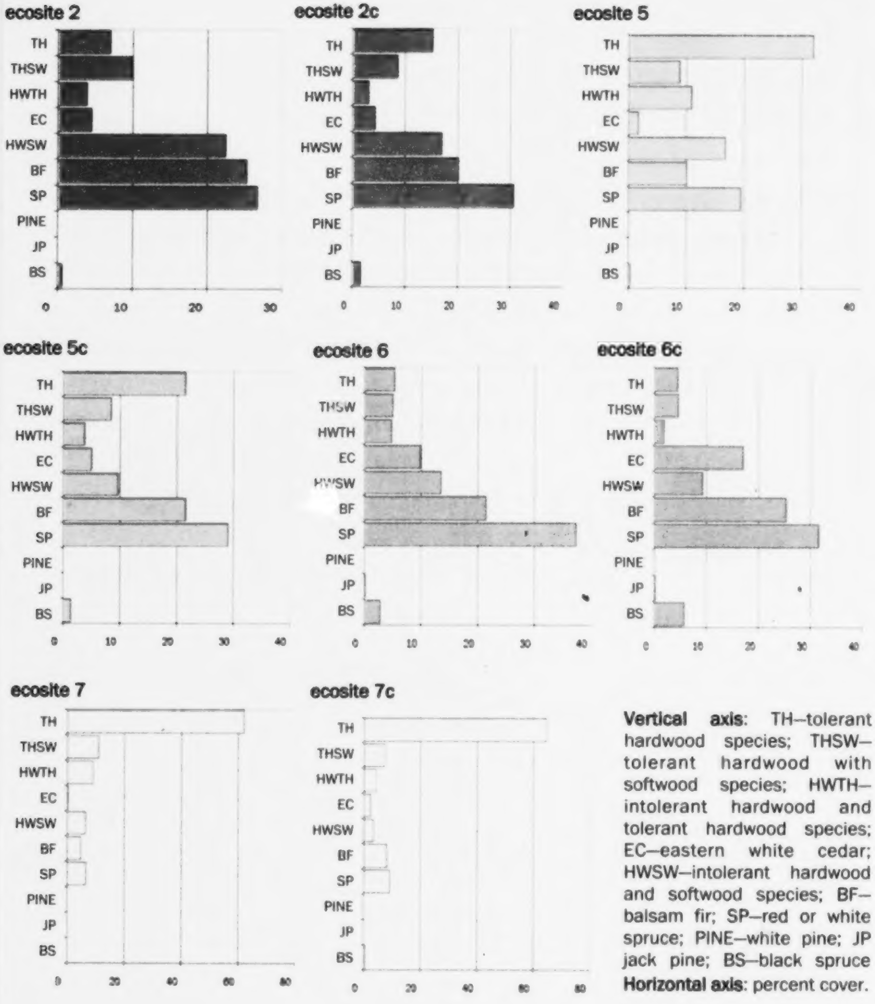


10% of Sisson Ecodistrict is not forested




3114
4014
4114
4214
2-1-2
2-1-4
3-1-1
3-1-2
3-2-2
3-4-1
4225
4226
4227
Maine
0
10
km
Ecosite map legend
ecosite
1
2
3
4
5
6
7
8
ecosite modifiers
c (calcareous)
o (organic)
f (periodically flooded)
h (high elevation)
m (mining debris)
water

Percent cover of forest stand types by ecosite

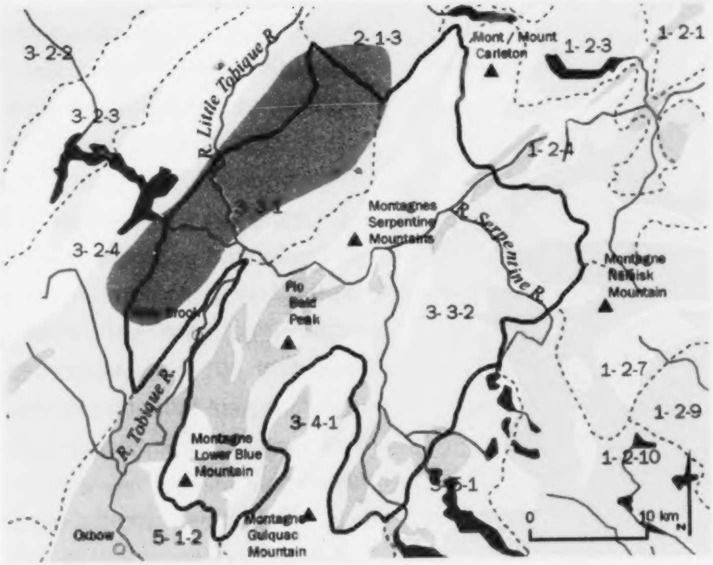


Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.

3.3. Serpentine Ecodistrict

The Serpentine Ecodistrict lies in north-central New Brunswick at the juncture of three ecoregions: the Central Uplands (to which it belongs), the Northern Uplands, and the Highlands.

Geology


3-2-2
3-2-3
3-2-4
2-1-3
Mont / Mount Carleton
1-2-3
1-2-1
R. Little Tobique R.
3-3-1
1-2-4
Montagnes Serpentine Mountains
R. Serpentine R.
Montagne Mountain
Brook
Pic Bald Peak
3-3-2
1-2-7
1-2-9
1-2-10
R. Tobique R.
3-4-1
Montagne Lower Blue Mountain
3-5-1
Oxbow
5-1-2
Montagne Gulquac Mountain
0
10 km
N

Geology of Serpentine Ecodistrict

Rock Types

Highly calcareous sedimentary

▨ Calcareous sedimentary

Non-calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites

Rocks in the Serpentine Ecodistrict occur in three areas: an eastern section, a western section, and a central core. The eastern section is composed of Ordovician greywacke, sandstone, and slate with granitic intrusions. The western area contains Devonian sedimentary strata that include shale, sandstone, and limestone. The central core, situated between the eastern and western areas, comprises a wide band of Silurian and Devonian felsic and mafic volcanic rocks with some metasedimentary rocks. Its highly resistant volcanic rocks create irregular plateaus and underlie several of the mountain ranges and peaks. A prominent regional fault transects the landscape northeastward from Nictau.

Landscape and Climate

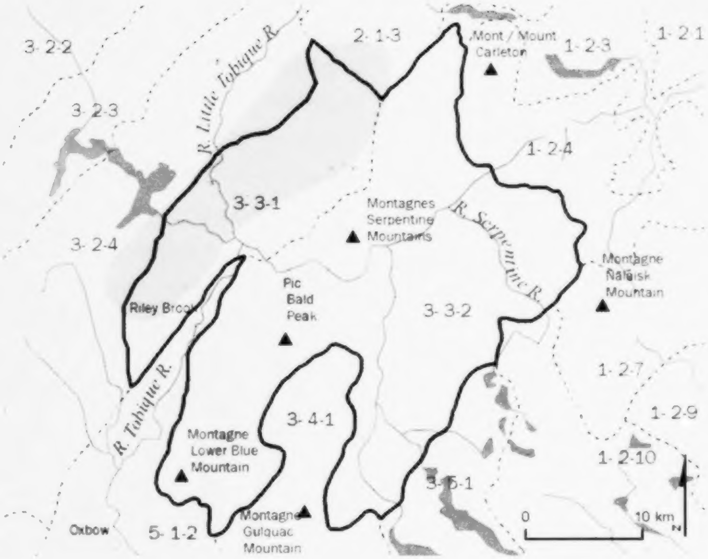
The geology here translates into a landscape of northeasterly trending ridges contrasting with valleys of metasedimentary rocks. The ridges are represented in the north by the Serpentine Mountain Range and Geologists Range, and farther south by single mountain peaks: Falls Mountain, Bald Peak, and Blue Mountain. The Geologists Range consists of mounts Bailey, Chalmers, Ells, Hartt, Matthew, and Robb, named in memory of the intrepid 19th-century geologists who laid the groundwork for subsequent mapping in the province.

The Serpentine Ecodistrict is surrounded by six other ecodistricts and has rivers and streams entering across its north, south, east, and west borders: the Serpentine, the Sisson Branch, the Little Tobique, the Mamozekel, the Right Hand Branch, and others. The flow direction for some rivers is influenced by bedrock lineaments. The Mamozekel River, for instance, follows the major fault running northeast from Nictau. Other rivers weave their way around the topographic maze of volcanic and metasedimentary rocks.

With few exceptions, the various rivers course as one towards

Geology

Rocks in the Serpentine Ecodistrict occur in three areas: an eastern section, a western section, and a central core. The eastern section is composed of Ordovician greywacke, sandstone, and slate with granitic intrusions. The western area contains Devonian sedimentary strata that include shale, sandstone, and limestone. The central core, situated between the eastern and western areas, comprises a wide band of Silurian and Devonian felsic and mafic volcanic rocks with some metasedimentary rocks. Its highly resistant volcanic rocks create irregular plateaus and underlie several of the mountain ranges and peaks. A prominent regional fault transects the landscape northeastward from Nictau.


3-2-2
R. Little Tobique R.
2-1-3
Mont / Mount Carleton
1-2-3
1-2-1
3-2-3
1-2-4
3-3-1
Montagnes Serpentine Mountains
R. Serpentine R.
3-2-4
Montagne Nalaisk Mountain
Riley Brook
Pic Bald Peak
3-3-2
1-2-7
R. Tobique R.
3-4-1
1-2-9
Montagne Lower Blue Mountain
1-2-10
3-5-1
Oxbow
5-1-2
Montagne Gulquac Mountain
0
10 km
N

Geology of Serpentine Ecodistrict

Rock Types

Highly calcareous sedimentary

Calcareous sedimentary

Non-calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites

Landscape and Climate

The geology here translates into a landscape of northeasterly trending ridges contrasting with valleys of metasedimentary rocks. The ridges are represented in the north by the Serpentine Mountain Range and Geologists Range, and farther south by single mountain peaks: Falls Mountain, Bald Peak, and Blue Mountain. The Geologists Range consists of mounts Bailey, Chalmers, Ells, Hartt, Matthew, and Robb, named in memory of the intrepid 19th-century geologists who laid the groundwork for subsequent mapping in the province.

The Serpentine Ecodistrict is surrounded by six other ecodistricts and has rivers and streams entering across its north, south, east, and west borders: the Serpentine, the Sisson Branch, the Little Tobique, the Mamozekel, the Right Hand Branch, and others. The flow direction for some rivers is influenced by bedrock lineaments. The Mamozekel River, for instance, follows the major fault running northeast from Nictau. Other rivers weave their way around the topographic maze of volcanic and metasedimentary rocks.

With few exceptions, the various rivers course as one towards their common endpoint, which is the hub-like confluence of rivers just north of Nictau. Once at the confluence, the combined rivers pour their waters into the Tobique River, which then heaves southward beyond the ecodistrict and into the Saint John River. The name *nictau* comes from the Maliseet *niktawk*, which means *forks*, an apt description for the site of forked rivers.

Lakes in the ecodistrict are few and tiny, as the landscape offers limited opportunities for the accumulation of large bodies of water. Elevations here commonly exceed 400 m. They reach a peak of 632 m at Bald Peak, which rises above its surroundings and was described by one early naturalist as "the most striking...and mountain-like mountain in New Brunswick." Its unstable talus slopes are craggy with angular volcanic boulders that reach up to 1 m in diameter.

Cool, moist climatic conditions prevail here. Orographic lifting causes the ecodistrict to intercept moisture from the prevailing westerlies, bringing relatively high levels of precipitation.

Soils

The higher hilltops are covered with soils of the Lomond Unit that are derived from stony residual materials of volcanic origin. These areas tend to support only slow-growing coniferous stands, a result of the combined influences of low inherent fertility and harsh climate. By contrast, the more sheltered lower hills and mid-slopes are dominated by compact, sandy loams to loams derived mainly from metasedimentary rocks. These soils are associated with the Holmesville and Long Lake units and support good-quality, tolerant hardwood stands.

Gagetown Unit soils appear here as coarse-textured glaciofluvial material along the upper stretches of Blue Mountain Brook. Gravelly, sandy loams derived from a mixture of igneous and sedimentary bedrock represent the Irving and Britt Brook units; they can be found east of Blue Mountain or in scattered locations along the Right Hand Branch of the Tobique River. Hummocky terrain in these locales has made for varied drainage, causing the soils to support more coniferous than hardwood vegetation.

Biota

Forests in this ecodistrict reflect their transitional position between the Central Uplands, Northern Uplands, and Highlands ecoregions. The dominant forest cover is balsam fir with white spruce, red spruce, and black spruce, an assemblage similar to that in the Ganong Ecodistrict. However, the forests contain sugar maple and yellow birch with some beech, species with a more southern affinity. An additional southern element here is the predominance of red spruce over white spruce, in contrast to what is seen in the colder and wetter Ganong Ecodistrict.

The tops of the volcanic mountains (2h) are dominated by coniferous forest, whereas their dry, steep mid-slopes (4) present a more mixed forest of sugar maple, balsam fir, yellow birch, and red spruce. The proportions vary with elevation. The moist, upper acidic slopes (7) have a high percentage of mixed forest with balsam fir, yellow birch, red maple, and sugar maple, with occasional white spruce and red spruce. The moist mid-slopes (5) and flatlands have comparatively more balsam fir with less red spruce and white spruce. The even damper areas with poorly drained soils (3) support cedar, balsam fir, and black spruce.

Repetitive, historic fires in places have converted areas formerly dominated by a coniferous cover into a mixed forest of white birch with yellow birch, red maple, and trembling aspen.

Settlement and Land Use

The ecodistrict lies within traditional Maliseet territory and was used regularly for hunting game and for travelling overland between the Saint John and Nepisiguit rivers. The route involved a canoe trip up the Tobique River through the Little Tobique River to Nictau Lake, from which point a short portage led to Nepisiguit Lake and the Nepisiguit River. The Maliseet traditionally have regarded Bald Peak as a site of spiritual and ceremonial significance. The Maliseet name for the peak is *nadakidgeetch*, which may have meant *bald head*. Blue Mountain reportedly has a site near the top that feels warm to the hand, a place where hunters can sleep without cover in mid-winter and where snow always melts.

Major waterways were logged throughout the late 1700s and 1800s, especially along the more accessible rivers. Forest tracts in this ecodistrict are divided mainly between industrial freehold land and Crown land. Nictau is the only permanent community in the ecodistrict and is home to several outfitters who frequent the Tobique area for hunting and fishing expeditions.

Base-metal deposits have been explored at Blue Mountain Lake and Bald Peak but were never commercially developed. More tantalizing are the placer gold showings discovered along the

Serpentine River and the Right Hand Branch of the Tobique River. The showings add fuel to persistent rumours of gold in the area that date back to the early 1800s. The most intriguing story involves George Giberson who discovered gold nuggets along a tributary of the Serpentine River in the late 1840s shortly before dying under mysterious circumstances. Another early report cites that ruffed grouse shot along the Serpentine River often were found to have gold particles in their crops.

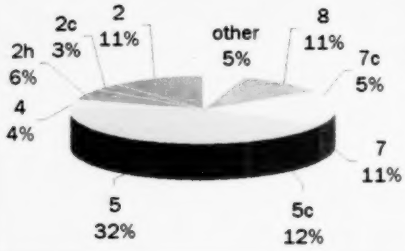
Bald Peak is a prominent landscape feature in the Serpentine Ecodistrict, and a favourite destination for hikers.

Ecodistrict at a Glance

Ecoregion: Central Uplands
Area: 88, 761 ha
Average elevation above sea level: 357 m
Average May–September precipitation: > 500 mm
Average annual degree–days above 5°C: 1300 – 1450

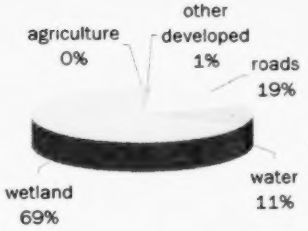
95% of Serpentine Ecodistrict has forest cover

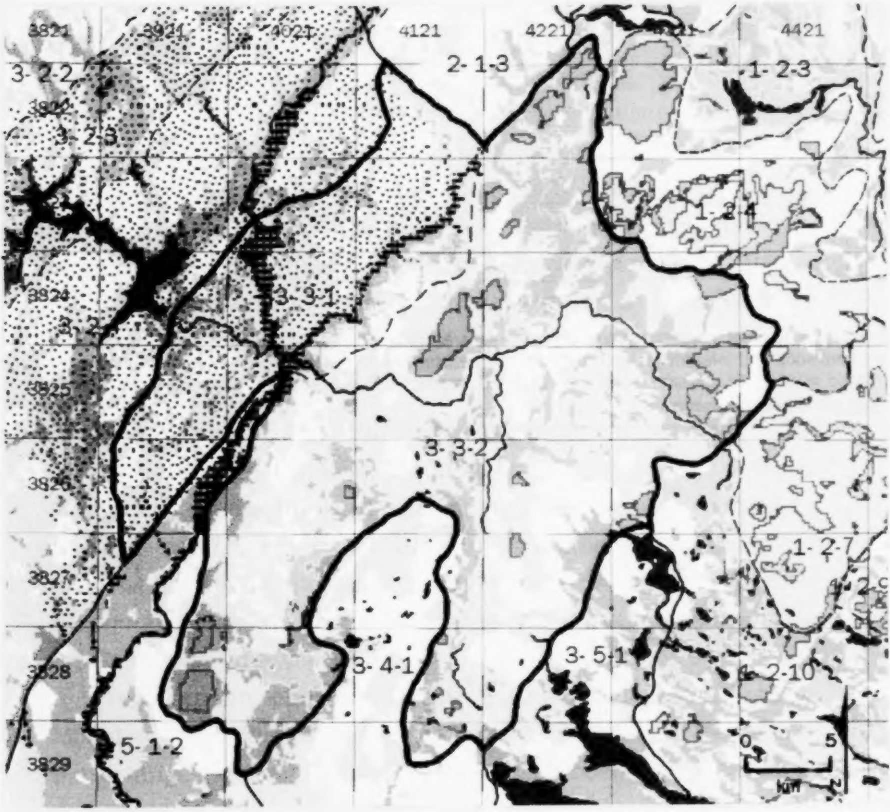
ecosite coverage of forest area



5% of Serpentine Ecodistrict is not forested

uses of non-forest area




3821
3921
4021
4121
4221
4321
4421
3-2-2
3822
3-2-3
3824
3-2
3825
3826
3827
3828
3829
3-3-1
2-1-3
1-2-3
1-2-4
3-3-2
1-2-7
3-4-1
3-5-1
1-2-10
5-1-2
0
5
km
N

Ecosite map legend

ecosite

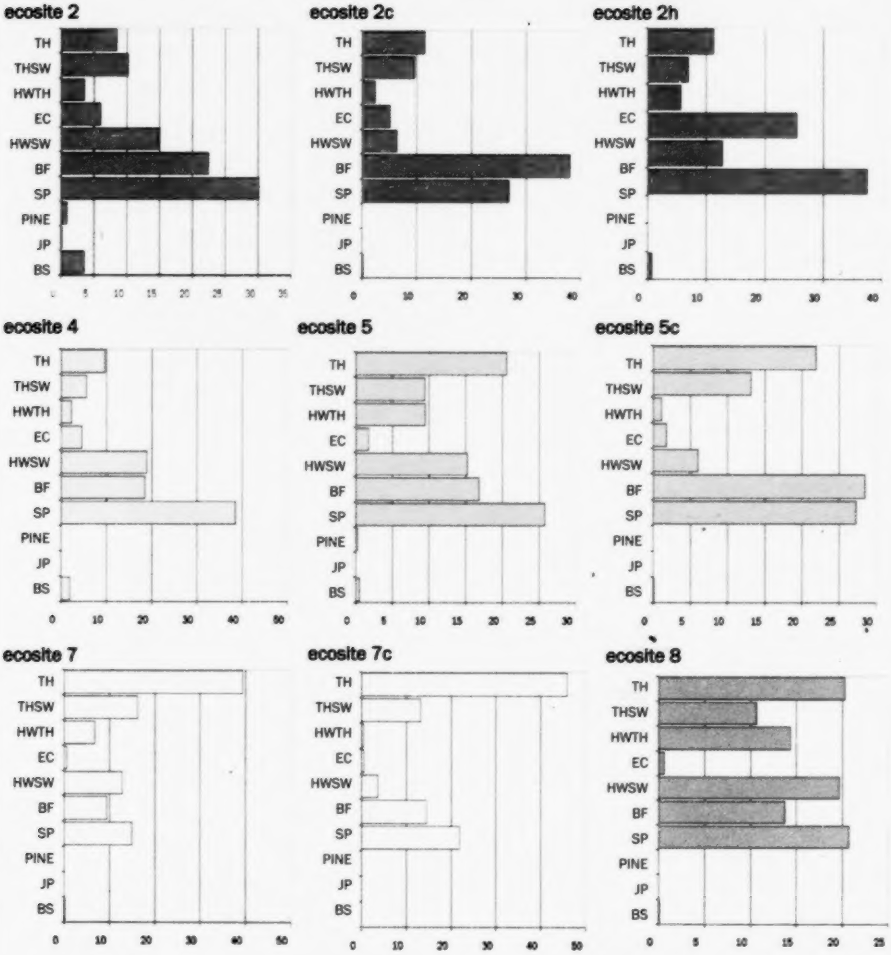
1
▨ 2
▨ 3
4
▨ 5
▨ 6
7
▨ 8

ecosite modifiers

▨ c (calcareous)
■ o (organic)
▤ f (periodically flooded)
☐ h (high elevation)
▨ m (mining debris)

■ water

Percent cover of forest stand types by ecosite



Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.

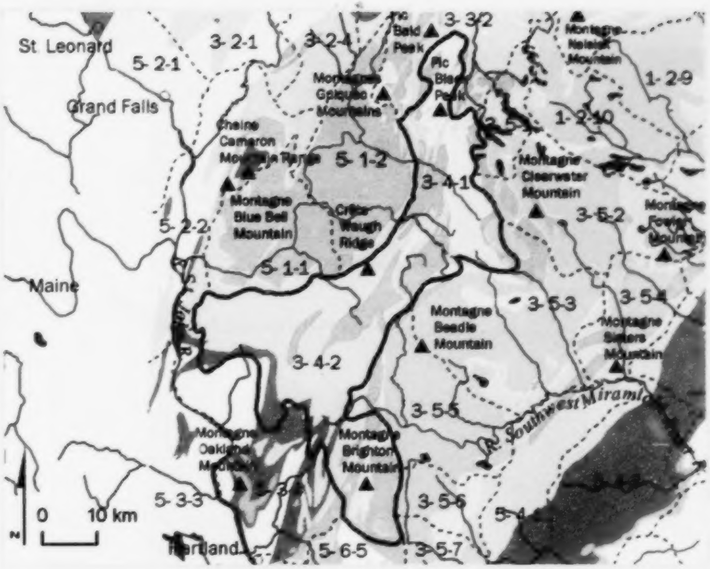
3.4. Brighton Ecodistrict

The hilly Brighton Ecodistrict lies in west-central New Brunswick. It has a long and narrow shape and penetrates far south into the Valley Lowlands Ecoregion.

Geology

Brighton Ecodistrict can be divided into three distinct geological areas: a northern lobe that stretches from the northern boundary down to the railway line, a central plateau that reaches from the railway line south to about Golden Ridge, and a small southern lobe.

The northern lobe is underlain by northeast-trending bands of Devonian felsic and mafic volcanic rocks of the Costigan Formation, and flanked by a narrower zone of Devonian metasedimentary rocks along the western margin. The metasedimentary rocks are mainly quartzose sandstone, siltstone, and slate. The central plateau contains Devonian metasedimentary rocks overlying Silurian sandstone, siltstone, and slate.


St. Leonard
Grand Falls
Maine
Hartland
5-2-1
3-2-1
3-2-4
3-3-2
Pic Bald Peak
Pic Black Peak
Montagne Gulquac Mountains
Chaine Cameron Mountain Range
Montagne Blue Bell Mountain
Crête Waugh Ridge
5-1-2
5-2-2
5-1-1
3-4-1
3-4-2
Montagne Nelelet Mountain
1-2-9
1-2-10
Montagne Clearwater Mountain
3-5-2
Montagne Fowler Mountain
3-5-3
3-5-4
Montagne Beadle Mountain
Montagne Sisters Mountain
3-5-5
Southwest Miramichi
Montagne Oakland Mountain
Montagne Brighton Mountain
5-3-3
3-5-6
5-4
5-6-5
3-5-7
0
10 km
N

Geology of Brighton Ecodistrict

Rock Types

Highly calcareous sedimentary

Calcareous sedimentary

Non-calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites

The southern lobe has a diverse assemblage dominated by Devonian gabbroic, granitic, and felsic volcanic rocks that in turn are overlain just west of Brighton Mountain by a small unit of Carboniferous sedimentary strata of the Carlisle Formation.

Landscape and Climate

The geology of the Brighton Ecodistrict supports a varied landscape of high plateaus, mountain ranges, ridges, and peaks. Waugh Ridge along the northwestern boundary consists of resistant metasedimentary rocks that form an escarpment overlooking the low, flat terrain of the Tobique River basin. A metasedimentary escarpment of Silurian rocks is situated farther south and overlooks the Saint John River valley.

The northern lobe contains the Gulquac Mountains, Costigan Mountains, Divide Mountains, and Black Mountains. The last of these ranges rise almost half a kilometre above its surroundings and contains the highest peak (681 m) in the ecodistrict. The

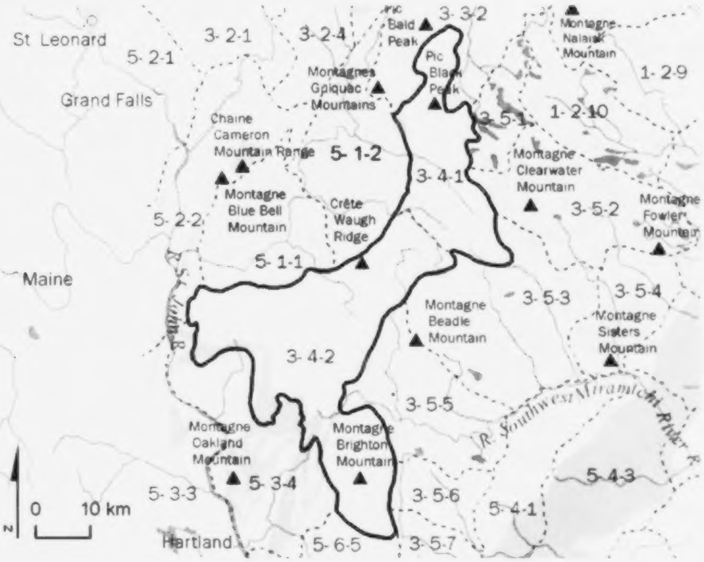
3.4. Brighton Ecodistrict

The hilly Brighton Ecodistrict lies in west-central New Brunswick. It has a long and narrow shape and penetrates far south into the Valley Lowlands Ecoregion.

Geology

Brighton Ecodistrict can be divided into three distinct geological areas: a northern lobe that stretches from the northern boundary down to the railway line, a central plateau that reaches from the railway line south to about Golden Ridge, and a small southern lobe.

The northern lobe is underlain by northeast-trending bands of Devonian felsic and mafic volcanic rocks of the Costigan Formation, and flanked by a narrower zone of Devonian metasedimentary rocks along the western margin. The metasedimentary rocks are mainly quartzose sandstone, siltstone, and slate. The central plateau contains Devonian metasedimentary rocks overlying Silurian sandstone, siltstone, and slate.


St Leonard
5-2-1
Grand Falls
3-2-1
3-2-4
Pic Bald Peak
3-3-2
Montagne Nalaisk Mountain
Montagnes Gulquac Mountains
Pic Black Peak
1-2-9
3-5-1
1-2-10
Chaine Cameron Mountain Range
5-1-2
3-4-1
Montagne Clearwater Mountain
Montagne Blue Bell Mountain
Crête Waugh Ridge
5-2-2
3-5-2
Montagne Fowler Mountain
5-1-1
Maine
3-5-3
3-5-4
Montagne Beadle Mountain
Montagne Sisters Mountain
3-4-2
R. Southwest Miramichi River
3-5-5
Montagne Oakland Mountain
Montagne Brighton Mountain
5-3-4
5-4-3
5-3-3
3-5-6
5-4-1
N
0
10 km
Hartland
5-6-5
3-5-7

Geology of Brighton Ecodistrict

Rock Types

Highly calcareous sedimentary

Calcareous sedimentary

Non-calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites

The southern lobe has a diverse assemblage dominated by Devonian gabbroic, granitic, and felsic volcanic rocks that in turn are overlain just west of Brighton Mountain by a small unit of Carboniferous sedimentary strata of the Carlisle Formation.

Landscape and Climate

The geology of the Brighton Ecodistrict supports a varied landscape of high plateaus, mountain ranges, ridges, and peaks. Waugh Ridge along the northwestern boundary consists of resistant metasedimentary rocks that form an escarpment overlooking the low, flat terrain of the Tobique River basin. A metasedimentary escarpment of Silurian rocks is situated farther south and overlooks the Saint John River valley.

The northern lobe contains the Gulquac Mountains, Costigan Mountains, Divide Mountains, and Black Mountains. The last of these ranges rise almost half a kilometre above its surroundings and contains the highest peak (681 m) in the ecodistrict. The southern lobe has only one truly mountainous feature, Brighton Mountain, whose 540 m summit reflects its felsic volcanic composition.

Rivers in the area alternate topographically with the mountain ranges. Blue Mountain Brook flows in a valley between the Blacks and Gulquacs, and the North Gulquac River separates the Gulquacs from the Costigans. The Gulquac River separates the Costigans from an unnamed mountain range to the south, eroding the bedrock heavily along its central reaches. Farther south, the Left Hand Branch of the River de Chute performs a fluvial slalom course between half a dozen peaks before entering the Wapske River.

The rivers drain one of either the Saint John or Miramichi river watersheds. Some rivers reach the Saint John indirectly via the Tobique or Nashwaak rivers. Others, such as the deeply incising North Branch Monquart Stream, flow directly into the Saint John River. A few rivers head eastward to join tributaries of the Southwest Miramichi River.

The high elevations here result in abundant summer precipitation and a tendency toward cool temperatures, particularly in the northeast. Temperatures farther south are somewhat moderated by the broad, warmer valleys of the Saint John and Tobique rivers.

This aerial view of the headwaters of Howard Brook is on the western border of the Brighton Ecodistrict . The boundary of the Valley Lowlands Ecoregion crosses Howard Brook at the left of this photograph.

Soils

Areas underlain by felsic volcanic rocks typically have shallow, stony soils of the Lomond Unit on the hilltop sites and compact loams of the Popple Depot Unit on the low ridges and slopes. These soils have low fertility and support poor-quality hardwoods mixed with coniferous vegetation. In areas underlain by metasedimentary rocks, the hilltops are covered with shallow, stony loams of the Glassville Unit. The strong slopes tend to have deeper, gravelly loams of the McGee Unit, whereas the low ridges and broad valleys display compact loams to sandy loams of the Holmesville Unit. Holmesville soils have moderate to good fertility and produce good-quality sugar maple and yellow birch with red spruce and white spruce.

Areas of mafic bedrock can yield relatively fertile loams, such as those of the Mafic Volcanic Unit, but have limited forest productivity where they are shallow and stony.

Biota

The strongly sloping terrain supports a widespread forest cover of tolerant hardwood. The acidic ridges (8) typically are covered with pure hardwood stands of sugar maple, yellow birch, and beech, which are joined on the acidic upper slopes (7) by red spruce and balsam fir. Coniferous communities tend to be more common over the mid-slope areas (5). Valley bottoms and lower slopes (2) support balsam fir and spruce with occasional white pine and hemlock, whereas the few poorly drained sites (3) are covered with cedar, black spruce, red spruce, and balsam fir.

Flowers of Dutchman's-breeches is a common sight in the Brighton Ecodistrict during the month of May .

The Long Lake area in the south encompasses several of the foregoing ecosites. It shelters a typical mixed forest and a range of habitats including hills, bogs, marshes, springs, and streams. Its upland ridges of sugar maple and beech with yellow birch overlook surrounding lowlands of balsam fir with white, red spruce, and black spruce. This peaceful site is one of the least disturbed locales in the vicinity.

A small plug of Silurian felsic volcanic rock intrudes the landscape in the western portion and is expressed topographically as Moose Mountain. The mountain's cool, moist crevices form a haven for the tiny Gaspé shrew, which has been reported from only a handful of locations in New Brunswick.

Settlement and Land Use

This ecodistrict lies within traditional Maliseet territory and has had an aboriginal presence for at least the last 4000 years. A major aboriginal settlement called *Negookgoot* was situated just outside the ecodistrict near present-day Tobique Narrows. Aboriginals from the village visited the Brighton Ecodistrict to hunt for game and to travel overland between the Saint John and Miramichi rivers. The route between the Saint John and Miramichi rivers involved a 24 km trip up the Shikatehawk River to a portage into the South Branch of the Southwest Miramichi River, which connects with the main Miramichi River.

The ecodistrict was logged repeatedly, beginning in the late 1700s, yet remained essentially unpopulated by non-aboriginals for many decades. The wilderness held little allure for incoming Loyalists, who huddled instead beside the gentler Saint John River. Scottish immigrants of the 1860s and 1870s were more accustomed to highland terrain and established the first inland communities at Argyle, Kilfoil, and Highlands. They were joined later by refugees from the 1877 Saint John Fire, who named their villages such as Beaumont after the men responsible for securing the land.

Even today, permanent communities occur only in the southern third of the ecodistrict and, without exception, are restricted to land underlain by metasedimentary rocks. The farming and processing of potatoes have long been the economic mainstays of this and neighbouring ecodistricts.

Forest tracts here are divided mainly between industrial freehold land and Crown land. Maple syrup is an important non-timber forest product in the area. Several base-metal deposits were explored in northern parts of the ecodistrict but were never commercially developed.

3.4. Brighton Ecodistrict at a Glance

Ecoregion: Central Uplands

Area: 155,840 ha

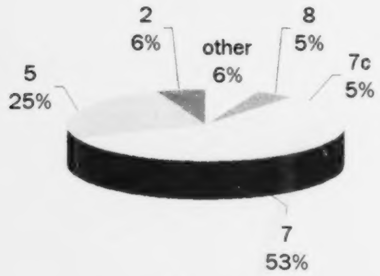
Average elevation above sea level: 399 m

Average May–September precipitation: > 500 mm

Average annual degree-days above 5°C: 1400–1600

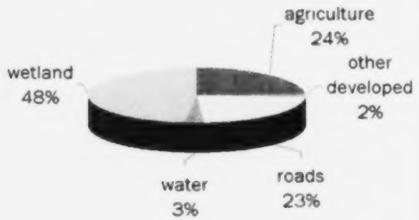
94% of Brighton Ecodistrict has forest cover

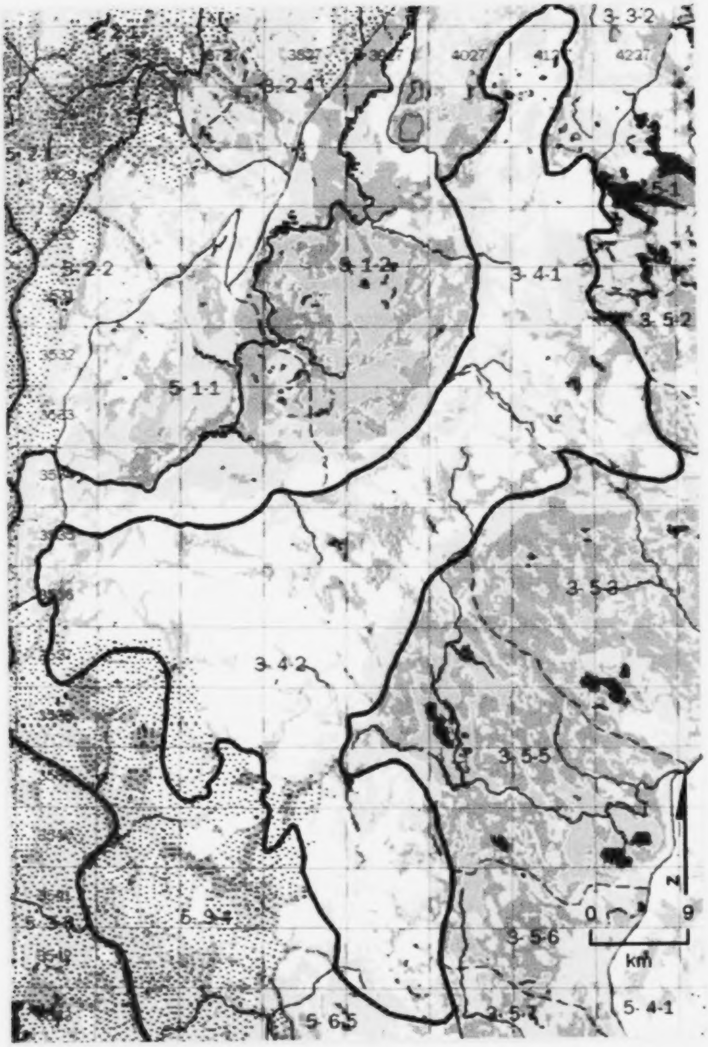
ecosite coverage of forest area



6% of Brighton Ecodistrict is not forested

uses of non-forest area




3-3-2
3-2-1
3527
3-2-4
4027
4237
5-7
3-2-2
3-1-2
3-4-1
3-5-2
5-1
3532
5-1-1
3-5-3
3-4-2
3-5-5
5-9-1
5-3-8
3-5-6
0
9
km
N
5-6-5
3-5-7
5-4-1

Ecosite map legend

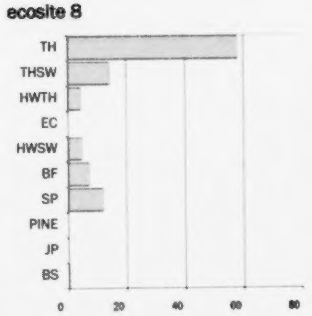
ecosite

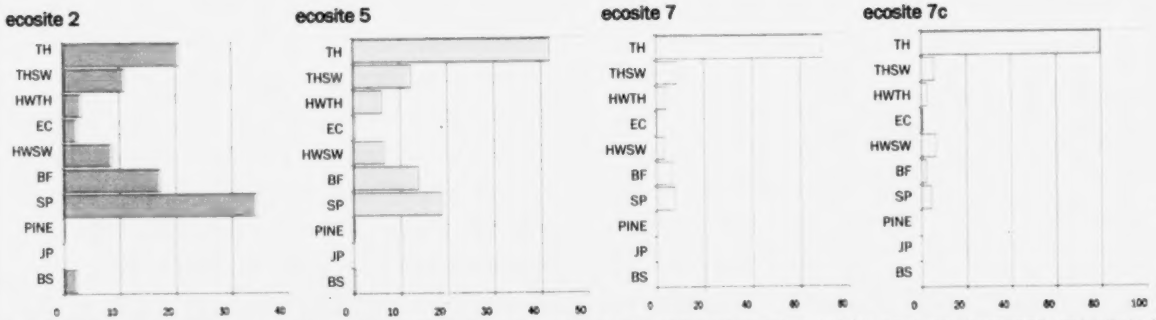
- 1
- ▨ 2
- ▨ 3
- 4
- 5
- ▨ 6
- 7
- ▨ 8

ecosite modifiers

- ⁘ c (calcareous)
- ■ o (organic)
- ☰ f (periodically flooded)
- ☐ h (high elevation)
- ⁘ m (mining debris)
- ■ water

Percent cover of forest stand types by ecosite

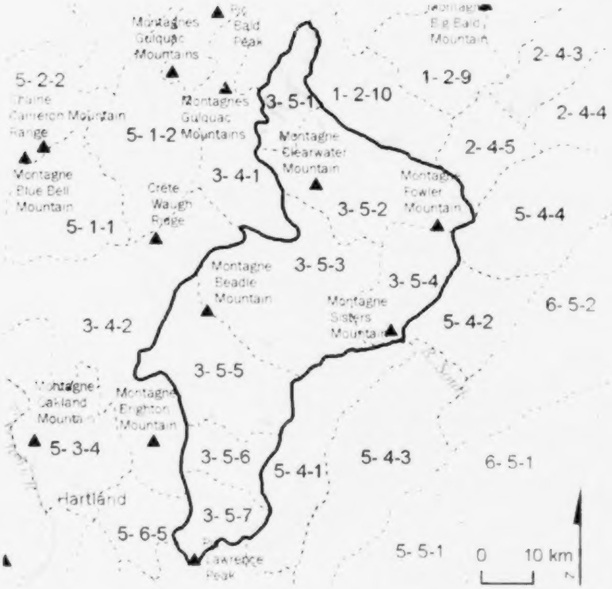




Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.

3.5. Beadle Ecodistrict

The Beadle Ecodistrict lies in central New Brunswick and is a lake-filled region of rolling hills separated by broad valleys.


Montagnes Gulquac Mountains
Big Bald Peak
Montagne Big Bald Mountain
5-2-2
Chaîne Cameron Mountain Range
Montagnes Gulquac Mountains
3-5-1
1-2-10
1-2-9
2-4-3
2-4-4
5-1-2
Montagne Clearwater Mountain
2-4-5
Montagne Blue Bell Mountain
Crête Waugh Ridge
3-4-1
Montagne Fowler Mountain
3-5-2
5-4-4
5-1-1
Montagne Beadle Mountain
3-5-3
3-5-4
Montagne Sisters Mountain
5-4-2
6-5-2
3-4-2
3-5-5
Montagne Oakland Mountain
Montagne Brighton Mountain
5-3-4
3-5-6
5-4-1
5-4-3
6-5-1
Hartland
3-5-7
5-6-5
Lawrence Peak
5-5-1
0
10 km
N

Geology of Beadle Ecodistrict

Rock Types

Highly calcareous sedimentary

Calcareous sedimentary

Non-calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites

Geology

The central core of the Beadle Ecodistrict is dominated by intrusive igneous material, mainly Devonian gabbroic rocks and Ordovician granites, with Devonian and possibly younger granites. A Jurassic diabase dyke skirts the western side of Howard Peak in the extreme south of the ecodistrict.

Elsewhere, the land is underlain by a diverse rock assemblage. Small, irregular zones of Cambrian or older schist and gneiss occur in two main areas: north of Nashwaak Lake and south of Trousers Lake. Narrow bands of Ordovician metasedimentary strata characterize the landscape around Napadogan, Louis Lake, Long Lake, and Falls Brook. As well, small patches of volcanic bedrock lie west of Gulquac Lake and west of Napadogan.

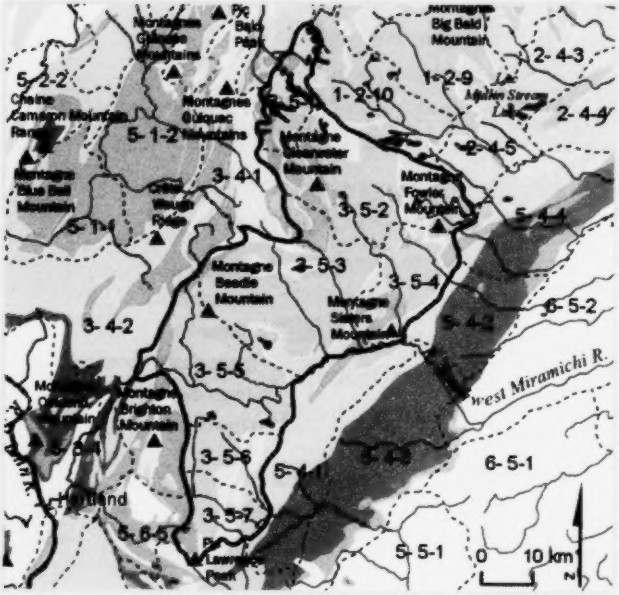
The Catamaran Fault in the northern third of the ecodistrict is marked by a chain of ponds, streams, and brooks. Beginning in the east at Red Rock, the fault trends westward through several unnamed elongated ponds, then continues into Lake Brook, Turnbull Brook, and Beaver Brook before crossing the western border.

Landscape and Climate

Elevations in this ecodistrict drop from slightly higher than 600 m in the north to barely higher than 300 m in the south. Two of the highest peaks up north are Mount Hind and Clark Mountain, both near Serpentine Lake. Beadle Mountain in the middle of the ecodistrict is underlain by a small stock of resistant granite that protrudes above the surrounding strata of less resistant, older sedimentary rocks. Mount Hind recalls geologist Henry Youle Hind, who mapped in New Brunswick during the 1860s. Clark Mountain commemorates Jack Clark of the Fraser lumber company, and Beadle Mountain was named after lumberman Joe Beadle, who lived in the vicinity in the mid-1800s.

3.5. Beadle Ecodistrict

The Beadle Ecodistrict lies in central New Brunswick and is a lake-filled region of rolling hills separated by broad valleys.


Pic Bald Peak
Montagne Big Bald Mountain
5-2-2
Chaîne Cameron Mountain Range
Montagnes Gulquac Mountains
5-1-2
1-2-10
1-2-9
Mullin Stream Lake
2-4-3
2-4-4
2-4-5
Montagne Blue Bell Mountain
3-4-1
Crête Waugh Ridge
Montagne Fowler Mountain
3-5-2
5-1-1
5-4-4
Montagne Beadle Mountain
2-5-3
3-5-4
6-5-2
3-4-2
5-4-2
3-5-5
West Miramichi R.
Montagne Brighton Mountain
6-5-1
3-5-6
5-4-1
Hartland
3-5-7
5-6-5
5-5-1
0
10 km
N

Geology of Beadle Ecodistrict

Rock Types

Highly calcareous sedimentary

▨ Calcareous sedimentary

Non-calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites

Geology

The central core of the Beadle Ecodistrict is dominated by intrusive igneous material, mainly Devonian gabbroic rocks and Ordovician granites, with Devonian and possibly younger granites. A Jurassic diabase dyke skirts the western side of Howard Peak in the extreme south of the ecodistrict.

Elsewhere, the land is underlain by a diverse rock assemblage. Small, irregular zones of Cambrian or older schist and gneiss occur in two main areas: north of Nashwaak Lake and south of Trousers Lake. Narrow bands of Ordovician metasedimentary strata characterize the landscape around Napadogan, Louis Lake, Long Lake, and Falls Brook. As well, small patches of volcanic bedrock lie west of Gulquac Lake and west of Napadogan.

The Catamaran Fault in the northern third of the ecodistrict is marked by a chain of ponds, streams, and brooks. Beginning in the east at Red Rock, the fault trends westward through several unnamed elongated ponds, then continues into Lake Brook, Turnbull Brook, and Beaver Brook before crossing the western border.

Landscape and Climate

Elevations in this ecodistrict drop from slightly higher than 600 m in the north to barely higher than 300 m in the south. Two of the highest peaks up north are Mount Hind and Clark Mountain, both near Serpentine Lake. Beadle Mountain in the middle of the ecodistrict is underlain by a small stock of resistant granite that protrudes above the surrounding strata of less resistant, older sedimentary rocks. Mount Hind recalls geologist Henry Youle Hind, who mapped in New Brunswick during the 1860s. Clark Mountain commemorates Jack Clark of the Fraser lumber company, and Beadle Mountain was named after lumberman Joe Beadle, who lived in the vicinity in the mid-1800s.

Several significant New Brunswick rivers trace their sources back to lakes or springs within this ecodistrict: the Renous, Dungarvon, Gulquac, Serpentine, and Keswick. Rivers in the north tend to angle westward towards the Tobique River, whereas those farthest south flow directly into the Saint John River. The igneous highlands are indented with numerous parallel streams that tumble down from the plateau in a series of rapids to reach the South Branch of the Southwest Miramichi River, which nudges the eastern border.

The presence of numerous lakes here is the result of several geological features. The primarily granitic bedrock is less porous than are other rock types and tends to accumulate larger bodies of water. The bedrock has few fractures or faults to facilitate water drainage. Moreover, the terrain is heavily clogged by glacial drift, which further encourages the formation of lakes, bogs, and ponds. The largest lakes in the ecodistrict occur along the northern margin and are dotted with granitic or gabbroic islands.

The ecodistrict has a cool, wet climate. Average summer precipitation is high, particularly in the north near Moose Lake, and the cool temperatures are surpassed only by those of the even colder Highlands Ecoregion.

Soils

The prevalence of granitic bedrock is mirrored in the dominance of granite-derived soils, especially the deep, non-compact sandy loams of the Juniper Unit. Shallow, stony tills of the Big Bald Mountain Unit are found on some isolated mountaintops, whereas the more loamy, compact soils of the Tuadook Unit occur on the lower hills and ridges. These coarser textured soils tend to be less fertile and support coniferous vegetation or poor-quality hardwoods.

Soils derived from mafic volcanic rocks, or from a mixture of metasedimentary and igneous rocks, occur mainly as compact loams. Under favourable drainage conditions, these soils are capable of producing good-quality tolerant hardwoods, red spruce, and balsam fir. Large, coarse-textured glaciofluvial deposits of the Gagetown Unit are derived from felsic volcanic rocks. These droughty soils are situated along Clearwater Brook and along headwaters of the Southwest Miramichi River near Juniper.

Biota

The forest cover reflects its transitional position between more coniferous forests of the Ganong Ecodistrict to the north and tolerant hardwood forests of the Brighton Ecodistrict to the west.

Granitic soils in areas of moist flatlands (2) and impeded drainage (3) commonly support balsam fir and spruce. As drainage improves on mid-slopes (5), mixed forests increase in prominence, with red spruce as the most abundant spruce species. This is in contrast with the adjacent Ganong Ecodistrict, where black spruce dominates over red spruce or white spruce.

Tolerant hardwood stands of sugar maple, yellow birch, and beech mixed with balsam fir and red spruce occur on the well drained upper slopes (7) and ridgetops (8). Such stand types are fairly common in the uplands of southern New Brunswick. The early successional community of intolerant hardwoods consists of white birch and red maple, mixed with balsam fir and red spruce.

The confluence of the north and south branches of the Southwest Miramichi River near Juniper is a significant waterfowl nesting and migration area. Nearby is the huge Juniper Barren north of Juniper Station, a large bog and fen complex. It measures about 4 sq km and was harvested in the past for peat moss. Today it harbours a population of the white-fringed orchis.

Some of the many lakes in the Beadle Ecodistrict have interesting biotic features. The mixed forests around Moose Lake protect one of the few provincial sites for northern wild licorice. A deadwater stretch along the North Renous River near Louis Lake attracts several butterflies not commonly seen in southern New Brunswick (the hoary comma and the western pine elfin) and one rare moth (the yellow-banded day sphinx).

Bird species also abound in and around the lakes and bogs. Miramichi Lake is home to bald eagle, osprey, and great blue heron; the Kennedy Lakes area has also hosted a great blue heron colony.

Settlement and Land Use

The Beadle Ecodistrict straddles the traditional territories of the Maliseet and Mi'kmaq, and the area has had an aboriginal presence for at least the last 2500 years. Natives living in adjacent areas visited the ecodistrict to hunt for game and to travel overland using portage trails between the Saint John and Miramichi rivers.

The valleys of all accessible rivers have been logged repeatedly, beginning in the late 1700s. Settlements historically were restricted to a strip defined first by the railroad in the early 1900s and later by Highway 107. The main communities today are Napadogan in the east and Juniper in the west, the latter of which was established as a lumbering centre in the early 1900s. The ecodistrict derives much of its economic livelihood from regional forest operations. Forest tracts in this ecodistrict are divided between industrial freehold land, small private woodlots, and Crown land.

The area's granitic rocks first sparked economic interest in the 1860s when geologist Charles Robb discovered molybdenite in quartz veins along the Southwest Miramichi River. Several base-metal deposits have since been located, but the only sizeable operation was a tungsten mine at the junction of Burnthill Brook and the Southwest Miramichi River. The Burnthill property was worked sporadically in the early to mid-1900s. The uncommon mineral beryl (the non-gem variety of emerald) occurs at Beaver Brook Lake and South Burnthill Brook.

Granitic boulders, sand, and gravel dropped in this area by retreating glaciers 11,000 years ago blocked the drainage of this area and created the basins in which the Kennedy Lakes developed.

3.5. Beadle Ecodistrict at a glance

Ecoregion: Central Uplands

Area: 267,979 ha

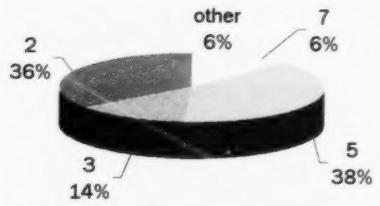
Average elevation above sea level: 374 m

Average May—September precipitation: > 500 mm

Average annual degree-days above 5 °C : 1400–1600

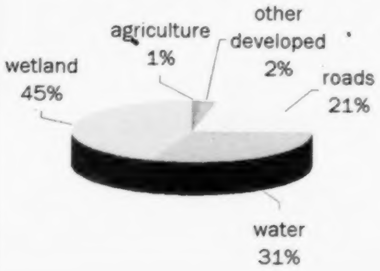
92% of Beadle Ecodistrict has forest cover

ecosite coverage of forest area

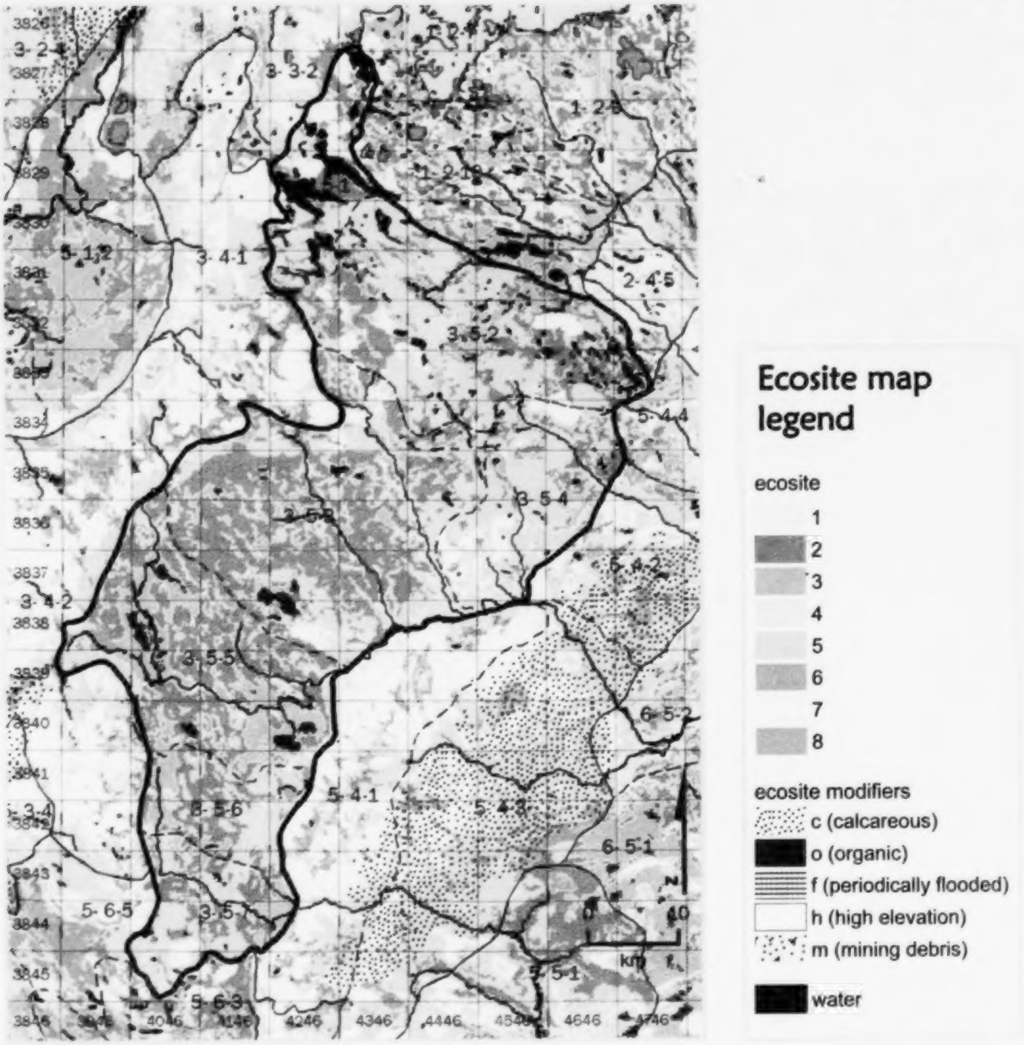


8% of Beadle Ecodistrict is not forested

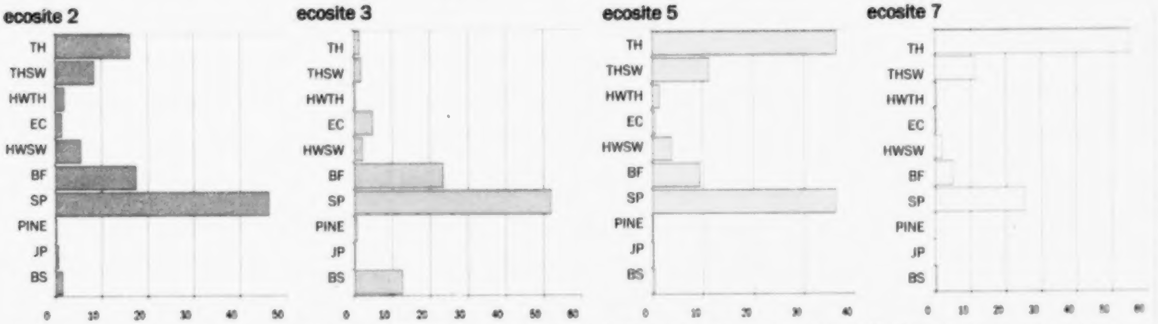
uses of non-forest area



The Juniper Barren is a large wetland complex that includes a large domed peat bog, pictured here on the left, and streamside alder swamps. Much of the wetland area of the Beadle Ecodistrict occurs here. Watercourses in the area are important breeding grounds for Miramichi River sea-run trout and Atlantic salmon.


3826
3-2-4
3827
3-3-2
3828
1-2-6
3829
1-2-1
3830
5-1-2
3-4-1
3831
2-4-5
3832
3-5-2
3833
3834
5-4-4
3835
3-5-4
3836
3-5-3
3837
5-4-2
3-4-2
3838
3-5-5
3839
6-5-2
3840
3841
5-4-1
5-3-4
3842
3-5-6
5-4-3
6-5-1
3843
N
5-6-5
3-5-7
0
10
3844
km
3845
5-5-1
5-6-3
3846
3946
4046
4146
4246
4346
4446
4546
4646
4746
Ecosite map legend
ecosite
1
2
3
4
5
6
7
8
ecosite modifiers
c (calcareous)
o (organic)
f (periodically flooded)
h (high elevation)
m (mining debris)
water

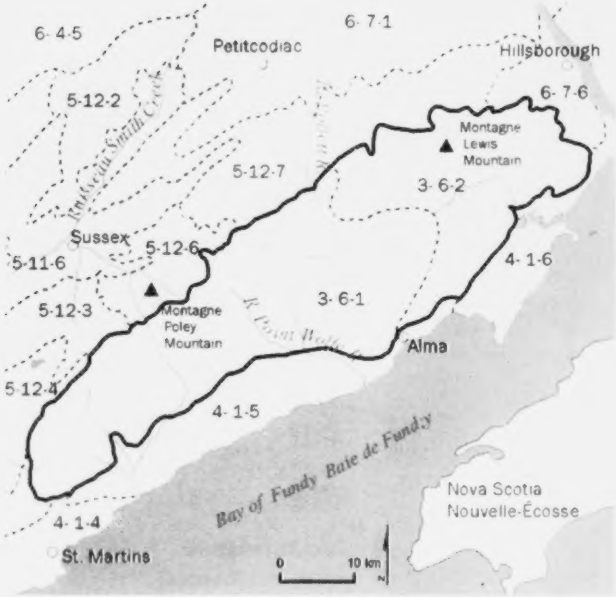
Percent cover of forest stand types by ecosite



Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.

3.6. Caledonia Ecodistrict

The Caledonia Ecodistrict is a broad upland plateau situated along the upper Bay of Fundy. It is a disjunct area of the Central Uplands Ecoregion that occurs mainly in the north-central part of the province.


6-4-5
Petitcodiac
6-7-1
Hillsborough
5-12-2
6-7-6
Kennebecasis Smith Creek
Montagne Lewis Mountain
5-12-7
3-6-2
Sussex
5-12-6
5-11-6
4-1-6
5-12-3
Montagne Poley Mountain
3-6-1
Alma
5-12-4
4-1-5
Bay of Fundy Baie de Fundy
Nova Scotia
Nouvelle-Écosse
4-1-4
St. Martins
0
10 km
N

Geology of Caledonia Ecodistrict

Rock Types

Highly calcareous sedimentary

Calcareous sedimentary

Non-calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites

Geology

The geology of the Caledonia Ecodistrict consists almost entirely of Precambrian bedrock. Some formations here are dated at around 600 million years BP and are among the oldest rocks in the province.

Much of the plateau is underlain by felsic to mafic volcanic rocks, interlayered metasedimentary strata, and small to medium-sized granitic plutons. The largest pluton forms a 10 km wide band trending northeast across the mid-section of the ecodistrict. Smaller granitic plutons occur near Ferndale, Hammondale, northwest of Alma, and the upper reaches of the Salmon River. A tiny gabbroic pluton sits along the north border just east of Chambers Settlement.

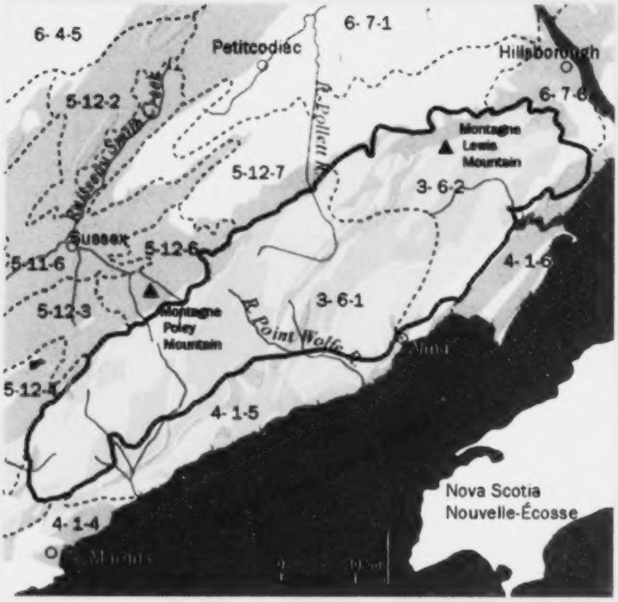
The ecodistrict contains three small areas of much younger lithologies. Beds of Mississippian red conglomerate, sandstone, and siltstone skirt the northeastern border between Prosser Brook and Caledonia Mountain. A thin band of Carboniferous sedimentary strata reaches along the border from Shepody Mountain down to Alma; these include grey sandstone and some calcareous rocks. A third area of tremendous botanical and geological significance encircles Wilson Brook and consists of Carboniferous limestone, gypsum, shale, and sandstone.

Landscape and Climate

The landscape here contains a central plateau of rolling, igneous hills chiselled by precipitous, river-lined gorges. The northwest border of the ecodistrict is buttressed by a string of mountains: Caledonia, Lewis, Hayward, Zachie Jonah, Sweet, Gowland and Boyd.

3.6. Caledonia Ecodistrict

The Caledonia Ecodistrict is a broad upland plateau situated along the upper Bay of Fundy. It is a disjunct area of the Central Uplands Ecoregion that occurs mainly in the north-central part of the province.



Geology of Caledonia Ecodistrict

Rock Types

- Highly calcareous sedimentary
- Calcareous sedimentary
- Non-calcareous sedimentary
- Early Carboniferous sedimentary
- Late Carboniferous sedimentary
- Mafic volcanic
- Felsic volcanic
- Granites and granodiorites

Geology

The geology of the Caledonia Ecodistrict consists almost entirely of Precambrian bedrock. Some formations here are dated at around 600 million years BP and are among the oldest rocks in the province.

Much of the plateau is underlain by felsic to mafic volcanic rocks, interlayered metasedimentary strata, and small to medium-sized granitic plutons. The largest pluton forms a 10 km-wide band trending northeast across the mid-section of the ecodistrict. Smaller granitic plutons occur near Ferndale, Hammondale, northwest of Alma, and the upper reaches of the Salmon River. A tiny gabbroic pluton sits along the north border just east of Chambers Settlement.

The ecodistrict contains three small areas of much younger lithologies. Beds of Mississippian red conglomerate, sandstone, and siltstone skirt the northeastern border between Prosser Brook and Caledonia Mountain. A thin band of Carboniferous sedimentary strata reaches along the border from Shepody Mountain down to Alma; these include grey sandstone and some calcareous rocks. A third area of tremendous botanical and geological significance encircles Wilson Brook and consists of Carboniferous limestone, gypsum, shale, and sandstone.

Landscape and Climate

The landscape here contains a central plateau of rolling, igneous hills chiselled by precipitous, river-lined gorges. The northwest border of the ecodistrict is buttressed by a string of mountains: Caledonia, Lewis, Hayward, Zachie Jonah, Sweet, Gowland and Boyd.

The central plateau averages about 300 m in elevation, peaking at 400 m in the Kent Hills. Rivulets emerge from lakes and hillsides in the plateau, then head downslope towards one of three destinations. Streams in the west reach the gentler waters of the Kennebecasis River, whereas those in the northeast enter the Petitcodiac River. The remainder drain into Chignecto Bay, eroding the bedrock so deeply that in places it appears to be severed in two.

The valley of Crooked Creek has deeply incised the bedrock in this scene near Riverside-Albert. The lower reaches of the brook are in the Fundy Coast Ecoregion, while the upper end is in the Central Uplands Ecoregion.

With so many incised river valleys, it is not surprising that the landscape surges with waterfalls. A tributary of the Northwest Branch of the Big Salmon River has several impressive cascades, the highest being about 15 m. Falls on Memel Creek near the town of Hopewell Hill provide a popular swimming spot for local residents. Forty-five River north of Alma has lovely salmon pools and waterfalls, one of which is named Match Factory Falls. The name comes from timber-driving days, when logs crashing over the falls would splinter into fragments ('match sticks') on the rocks below.

Karst topography is a distinctive feature of the ecodistrict. The extensive deposits of limestone and gypsum are susceptible to solution by circulating groundwater, which results in the formation of caves, sinkholes, and funnel-shaped depressions. New Brunswick's most extensive solution cave is situated 2 km south of Berryton and is over 300 m long.

The ecodistrict has a cool and wet climate, reflecting its high elevations and the moderating influence of the Bay of Fundy. Orographic lifting causes the area to intercept moisture-laden air masses from the bay. This factor and the frequent winter storms create a high annual precipitation of over 1400 mm. By contrast, the northerly adjacent ecodistricts lie in Caledonia's rain shadow and receive only 1000 mm or less of precipitation annually.

Soils

Most of the land here is covered with low-fertility soils derived from felsic volcanic rocks. The upland plateau is associated with shallow, stony soils of the Lomond Unit. The gentler slopes have deeper loams to sandy loams of the Popple Depot and Jacquet River units. The largest glaciofluvial deposit of felsic volcanic origin belongs to the Gagetown Unit and is found along the headwaters of the Big Salmon River.

Soils of granitic derivation appear in two large areas and several smaller areas and are moderately fertile. The larger zones are overlain mainly by deep, non-compact sandy loams of the Juniper Unit. Residual, stony soils of the Big Bald Mountain Unit cap the highest hills and steep slopes between Churches Corner and Prosser Brook. The more compact loams are found in scattered locations.

The few, restricted zones of Carboniferous sedimentary rocks are associated with highly fertile soils, mainly those belonging to the Reece, Sunbury and Parry units.

Biota

This ecodistrict is widely covered by tolerant hardwood forests. Its well drained hilltops and upper slopes (8, 7) support a tolerant hardwood forest of sugar maple, yellow birch, and beech, often associated with red spruce. Hardwood forest communities tend to be more common away from the cooling effects of the Bay of Fundy, especially in northern areas where white ash and ironwood also occur. One of the more pristine hardwood communities occurs at McManus Hill Conservation Area, where mature sugar maple, beech, and yellow birch protect a diverse understorey. Sweet Mountain east of Elgin is named for its groves of sugar maple.

The flatter upland areas and gentle mid-slopes (5) are associated with mixed forests of red spruce, yellow birch, and red maple with some balsam fir. Valley bottoms and flatlands with impeded drainage (2, 3) often support pure stands of spruce and balsam fir. The scarcity of pine and poplar (unlike in the adjacent Anagance Ecodistrict) suggests a low fire frequency due to the cool, wet climate. Hemlock is rare here but can be seen near Hillsborough on the south bank of Weldon Creek and the northeast slope of Caledonia Mountain.

The early successional community of intolerant hardwoods that follows tree harvesting consists mainly of white birch with yellow birch and balsam fir.

A combination of factors has endowed the Caledonia Ecodistrict with significant natural features. Fundy National Park lies partly within its boundaries, imparting a moderate degree of protection. The ecodistrict's interior is rugged and inaccessible to the average traveller. Moreover, it has small but productive zones of calcium-rich bedrock and soil that harbour rare species of plants. Two sites in particular are renowned for their outstanding populations of rare plant species: Mount Zackie Jonah east of Elgin and the gypsum cliffs near Albert Mines. The steep slopes of Mount Zackie Jonah harbour one of the very few provincial sites of the maple-leaved goosefoot and Back's sedge. The mountain's moist, calcareous ledges shelter the rare maidenhair spleenwort. The rare small-flowered anemone also grows here.

Settlement and Land Use

The Caledonia Ecodistrict straddles the traditional Maliseet and Mi'kmaq territory. The area has yielded one artifact that is 10,000 years old, dating from when the shores of a barely post-glacial New Brunswick lay farther inland. Aboriginals of more recent times used the ecodistrict to hunt for game and perhaps to quarry for chert and slate.

The earliest non-aboriginal settlers arrived in the middle 1700s, although many left the area decades later for more arable land. Abandoned graveyards lie beside the old Shepody Road between Fundy National Park and Hammondvale, and the adjacent forests contain apple trees planted long ago on early 19th-century farmsteads. Decayed dams and sluices can still be seen along some river gorges in the ecodistrict, remnants of former log-driving days.

The relative inaccessibility of the ecodistrict and its lack of long, navigable rivers discouraged commercial logging activities until the mid-1800s. Forest tracts here are divided between industrial freehold land, small private woodlots, and Crown land.

The wide geological variety has resulted in a diversity of economic mineral commodities, several of which have been mined. Deposits of gold, silver, base metals, and manganese were worked briefly within the last century, and Pollard Lake south of Mechanic Settlement produced quantities of diatomite. Dimension stone was quarried from Memel Settlement, Curryville, and elsewhere to construct buildings across New Brunswick. Gypsum quarries west and southwest of Hillsborough were active for nearly three centuries, until the 1980s.

The most exotic mineral was albertite, which was mined just southwest of Hillsborough. Albertite is a solid hydrocarbon mineral and was first recognized in Albert County, New Brunswick. The mineral was co-discovered in the late 1840s by (among others) Abraham Gesner, the first provincial geologist in New Brunswick and Canada, and the co-inventor of kerosene.

Modern settlements in the area are located mainly along the ecodistrict's perimeter where the plateau merges with the lower, more habitable terrain surrounding it. Regional occupations centre on farming, sugar bush operations, forestry, and tourism.

3.6. Caledonia Ecodistrict at a Glance

Ecoregion: Central Uplands

Area: 140, 789 ha

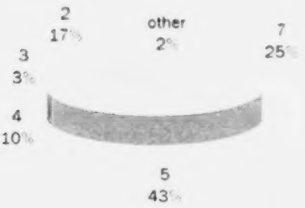
Average elevation above sea level: 290 m

Average May—September precipitation: 450—550 mm

Average annual degree-days above 5°C: 1500—1650

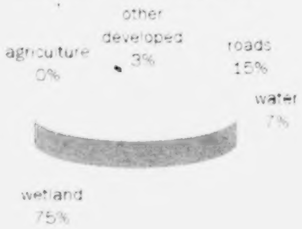
95% of Caledonia Ecodistrict has forest cover

ecosite coverage of forest area



5% of Caledonia Ecodistrict is not forested

uses of non-forest area



Ecosite map legend

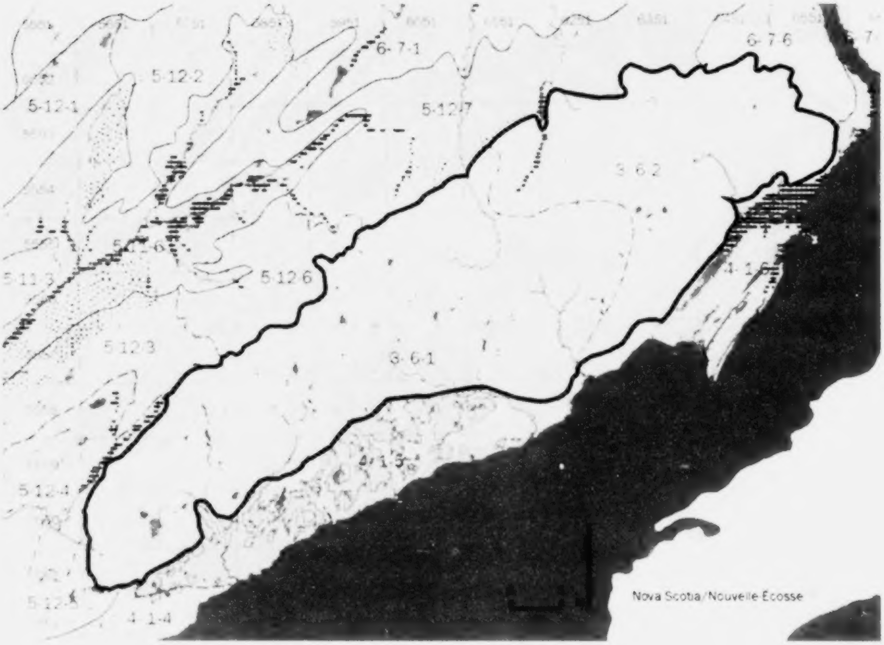
ecosite

1
2
3
4
5
6
7
8

ecosite modifiers

c (calcareous)
▨ o (organic)
▤ f (periodically flooded)
h (high elevation)
m (mining debris)

■ water


6-7-1
5-12-2
5-12-1
5-12-7
6-7-6
3-6-2
5-12-6
5-11-3
4-1-6
5-12-3
3-6-1
4-1-5
5-12-4
5-12-5
4-1-4
Nova Scotia/Nouvelle Ecosse

Modern settlements in the area are located mainly along the ecodistrict's perimeter where the plateau merges with the lower, more habitable terrain surrounding it. Regional occupations centre on farming, sugar bush operations, forestry, and tourism.

3.6. Caledonia Ecodistrict at a Glance

Ecoregion: Central Uplands

Area: 140, 789 ha

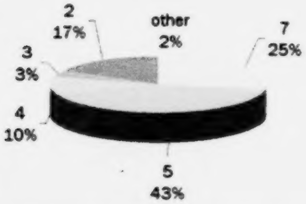
Average elevation above sea level: 290 m

Average May–September precipitation: 450–550 mm

Average annual degree-days above 5°C: 1500–1650

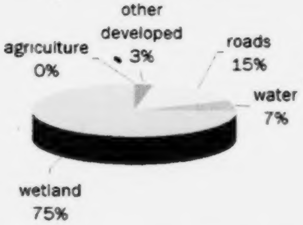
95% of Caledonia Ecodistrict has forest cover

ecosite coverage of forest area



5% of Caledonia Ecodistrict is not forested

uses of non-forest area



Ecosite map legend

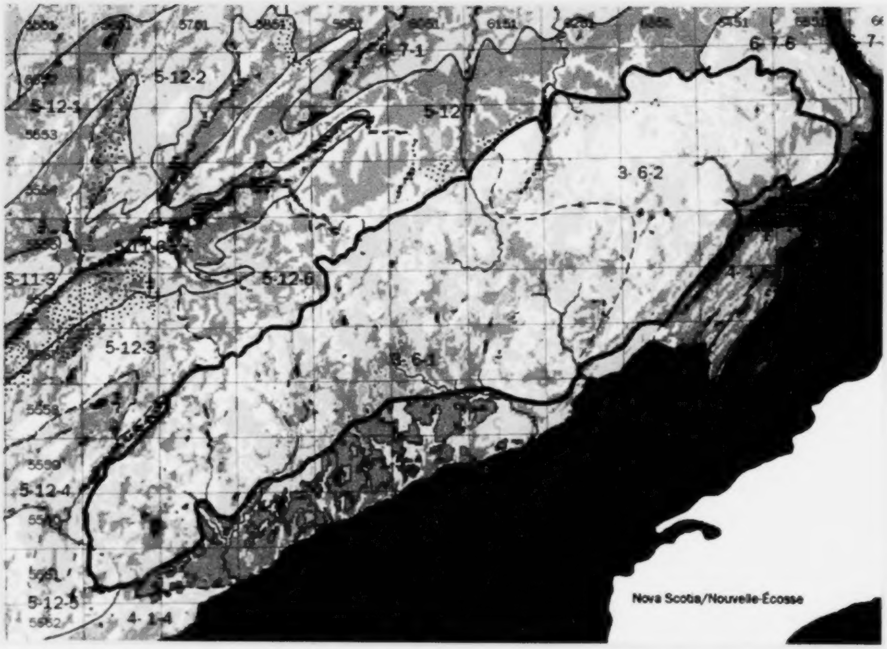
ecosite

- 1
- ▨ 2
- ▨ 3
- 4
- 5
- ▨ 6
- 7
- ▨ 8

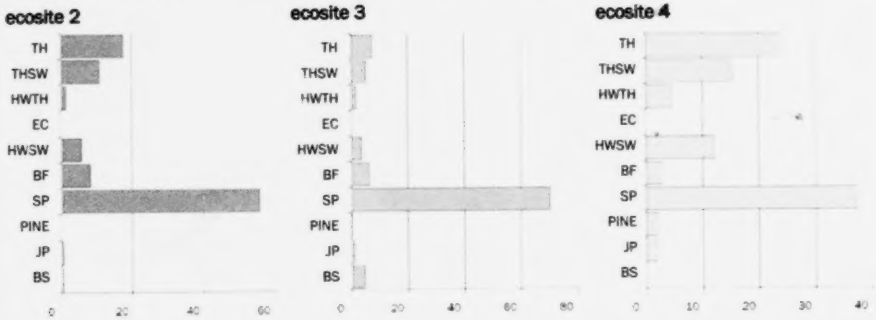
ecosite modifiers

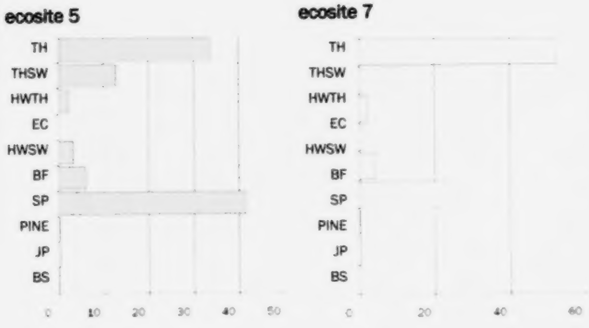
- ▨ c (calcareous)
- ■ o (organic)
- ▤ f (periodically flooded)
- ☐ h (high elevation)
- ▨ m (mining debris)

■ water

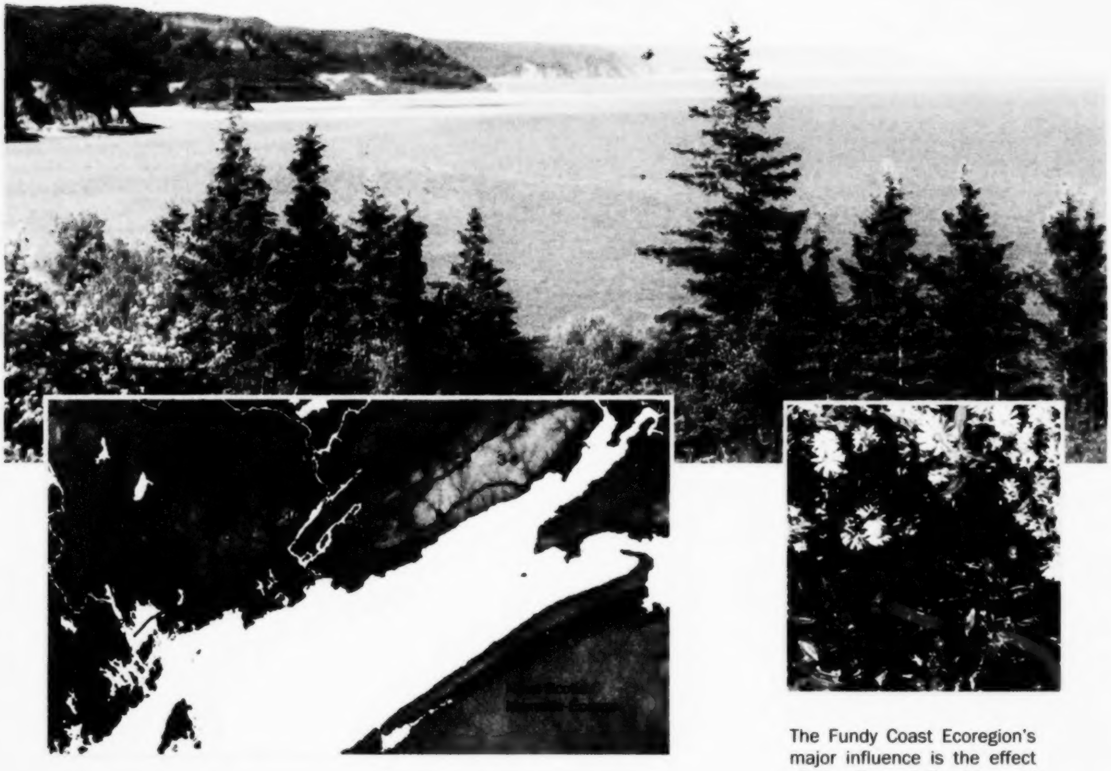


Percent cover of forest stand types by ecosite





Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.

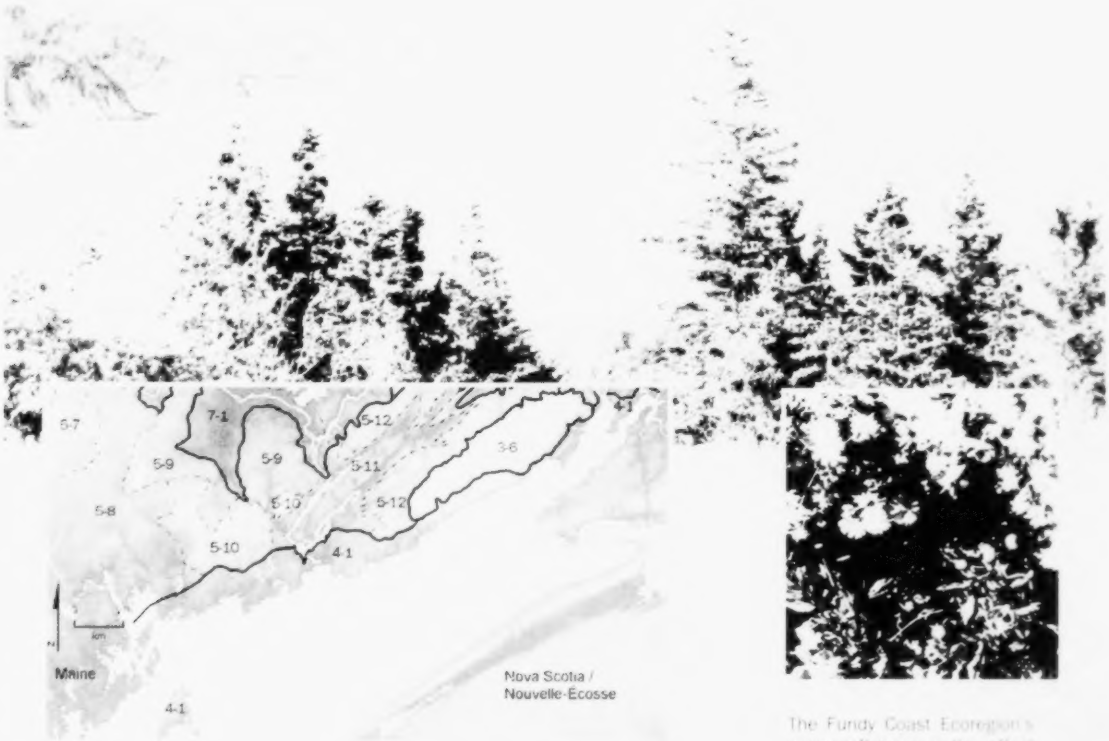


The Fundy Coast Ecoregion's major influence is the effect of the Bay of Fundy's cold waters on the climate and ecosystem character

Chapter 10

4. Fundy Coast Ecoregion

The Fundy Coast Ecoregion spans the entire southern coastline of New Brunswick along the Bay of Fundy from the east side of Passamaquoddy Bay to the east side of Shepody Bay. It also encompasses the Western Isles and Outer Isles that include Grand Manan, Campobello, Deer, and Machias Seal islands. The region features a unique type of raised bog, a maritime climate, and the world's highest tides. As a measure of the area's ecological and scenic significance, it also possesses a national park and nearly a dozen other areas dedicated to biological conservation, enjoying by far the largest number of officially protected areas of any New Brunswick ecoregion.



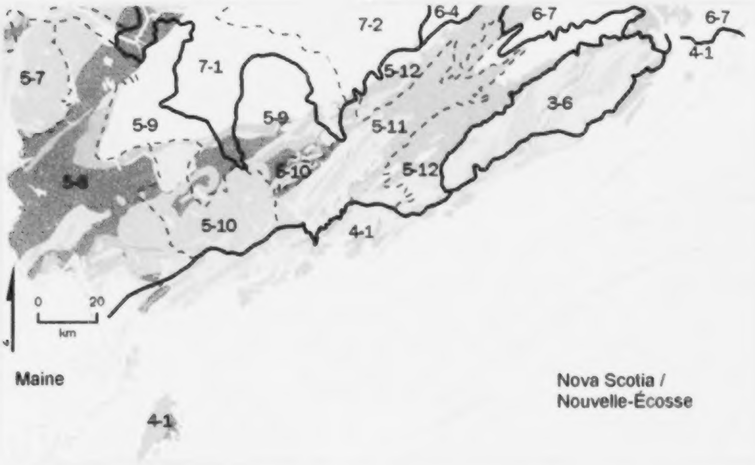
The Fundy Coast Ecoregion's major influence is the effect of the Bay of Fundy's cold waters on the climate and ecosystem character

Chapter 10

4. Fundy Coast Ecoregion

The Fundy Coast Ecoregion spans the entire southern coastline of New Brunswick along the Bay of Fundy from the east side of Passamaquoddy Bay to the east side of Shepody Bay. It also encompasses the Western Isles and Outer Isles that include Grand Manan, Campobello, Deer, and Machias Seal islands. The region features a unique type of raised bog, a maritime climate, and the world's highest tides. As a measure of the area's ecological and scenic significance, it also possesses a national park and nearly a dozen other areas dedicated to biological conservation, enjoying by far the largest number of officially protected areas of any New Brunswick ecoregion.

Geology and Landscape



Geology of Fundy Coast Ecoregion

Rock Types

- Highly calcareous sedimentary
- Calcareous sedimentary
- Non-calcareous sedimentary
- Early Carboniferous sedimentary
- Late Carboniferous sedimentary
- Mafic volcanic
- Felsic volcanic
- Granites and granodiorites

Rocks in the Fundy Coast Ecoregion range in age from Precambrian metasedimentary strata to Jurassic volcanic rocks, which represent the oldest and youngest rocks, respectively, in the province. Rocks of intermediate age also occur here, including the granites around St. George and Cape Spencer and the sedimentary strata at St. Martins and along the coast east of Fundy National Park.

The landscape owes much of its scenic diversity to the varied types of bedrock. Within a few kilometres it ranges from seaside salt marshes and estuaries to towering cliffs overlooking the Bay of Fundy. It supports gently rolling hills beside rugged shorelines and sandy beaches near woodlands full of wildflowers. Although elevations generally lie below 100 m, coastal cliffs can reach over 300 m.

All rivers in the ecoregion flow into the Bay of Fundy or one of its subsidiary bays and basins. Some rivers meet the ocean directly as waterfalls or swift streams, whereas others enter more gently through coastal estuaries or marshes before mingling with the salt water.

Climate

Time and tides have created the cave seen here near St. Martin's.

The Bay of Fundy is colder than either Northumberland Strait or Chaleur Bay (New Brunswick's two other defining bodies of salt water) and effectively moderates the climate in this ecoregion throughout the year. Water entering the bay undergoes strong tidal mixing twice daily, propelled by the world's highest tides. Winters are relatively mild and summers are markedly cool.

Persistent summer fog results when warm, moist air from the province's interior meets cold waters from the bay. The fog reduces the hours of available sunshine and contributes to lower summer temperatures. During the growing season, onshore breezes of cool, moist air flow in from the bay to replace warmer air rising from the land. Upon reaching the shore, the air is forced by topography to rise and yield its abundant moisture. The resulting precipitation gives this ecoregion some of the heaviest summer rainfalls in the province. A steep temperature gradient exists between the coastline and a few kilometres inland, where the land lies farther from sea water.

Swallowtail Lighthouse, Grand Manan Island. A ferry is running to Black's Harbour on the mainland and a herring weir are also visible. *Photograph © Ron Garnett--AirScapes.ca.*

Forest Cover

The cool, moist climate has led to a mainly coniferous forest cover. Although coniferous forests also dominate the Highlands Ecoregion, winter temperatures there are much colder than on the Fundy coast, which has the most moderate January temperatures in the province. For this reason, the coniferous community in the Fundy Coast Ecoregion is dominated by red spruce (an Appalachian species) together with balsam fir, black spruce, white spruce, and tamarack. Cedar is a predominant species on the limestone-derived soils around Saint John and in isolated places farther west.

The tolerant hardwood assemblage of yellow birch, sugar maple, and beech that thrives elsewhere in southern New Brunswick is rare here. These heat-loving species prefer well drained soils and are ill adapted to the Bay of Fundy's damp, cool summer weather. They occur only at higher elevations on the warmest and most protected sites along ecoregion borders.

The most common hardwoods are white birch, mountain ash, red maple, and some yellow birch. In the eastern part of the region, red maple and birches typically appear with balsam fir and red spruce, whereas in the western area, red maple and yellow birch occur with balsam fir and all three spruces. Research suggests that acidic fog and precipitation along the Fundy coast is an important source of stress for birch species, causing premature browning and dropping of foliage. The pollution sources that create these effects originate in southwest New Brunswick and the northeastern United States.

The fog, abundant precipitation, and low soil temperatures in summer together have limited the frequency of regional wildfires. Fire-dependent species such as jack pine and white pine occur in only a few locales, and the intolerant hardwood community includes mountain ash and white birch. Because of the cool, damp summers, the forest understorey can support boreal-type species such as rock cranberry on dry sites and cloudberry in peatlands. Some coastal ravines and bogs also harbour noteworthy species of arctic flora, which represent disjunct vestiges of vegetation that prevailed early in the post-glacial period (see Chapter 3).

In some locations, the vegetation here shows a sharp transition from predominantly coniferous coastal forests at lower elevations to mixed or deciduous forests over the warmer inland terrain. The occurrence of sugar maple and beech marks the transition to the Caledonia Uplands Ecoregion. Where the Fundy Coast Ecoregion borders the Mount Pleasant Ecodistrict of the Valley Lowlands Ecoregion, the boundary is less sharp, owing to a predominance of granitic bedrock and acidic soils. There, coniferous cover prevails in spite of the warmer climate.

Wetlands

The Fundy Coast Ecoregion has a rich diversity of wetland types. The most remarkable of these are the raised coastal bogs that occur mainly west of Saint John and across the international border in Maine.

As with other coastal bogs in the province, the Fundy bogs contain typical plants such as dwarf huckleberry, the lichen *Cladina terrae-novae*, and the mosses *Sphagnum imbricatum* and *Sphagnum austinii*. What most distinguishes the Fundy bogs, however, is their morphology and surface features. The bogs along the Fundy coast have generally formed in deep depressions that are topographically restricted. By contrast, bogs along the Chaleur and Northumberland coasts developed in shallow depressions and, over time, have coalesced into extensive complexes. The Fundy bogs have a limited number of small surface pools, whereas those along the east coast have many large surface pools, some the size of small lakes.

Another notable surface feature of the Fundy bogs is their scirpus lawns: vibrant carpets of mostly red mosses covered with the sedge *Scirpus caespitosus* in combination with other species such the lichen *Cladina terrae-novae*, or dwarfed shrubs such as leatherleaf or bog rosemary. Elsewhere in the province, scirpus lawns are restricted to small areas: around ponds in the Eastern Lowlands Ecoregion, and in narrow, wet hollows on the more inland bogs. Along the Fundy coast, however, the lawns are much more extensive for reasons that scientists have yet to fully understand. The red sphagnum mosses are variously treated as a single species or as a complex of one or several species that are difficult to discern.

Eastward along the coast from Saint John, the incidence of wetlands decreases as the topography grows more rugged, then increases again east of Rocher Bay where the bedrock and terrain are gentler. There, the interaction between high tides and lowlands has created a network of interesting estuaries and salt marshes.

Coastal marshlands in this ecoregion are unusual in that they comprise significant areas of both low and high salt marsh, unlike the Northumberland and Chaleur coasts, where low salt marsh is less common. Low salt marsh lies below the mean high-water mark, is flooded daily by tides, and features salt-water cord-grass as the dominant vegetation. High salt marsh lies above the mean high-water mark, experiences flooding only during the highest tides, and is dominated by salt-meadow grass and black grass.

4.1. Fundy Coastal Ecodistrict

The Fundy Coastal Ecodistrict comprises the southern coastline of New Brunswick along the Bay of Fundy from east Passamaquoddy Bay to Shepody Bay. It also encompasses the Western Isles, including Campobello, Deer, and Grand Manan islands.

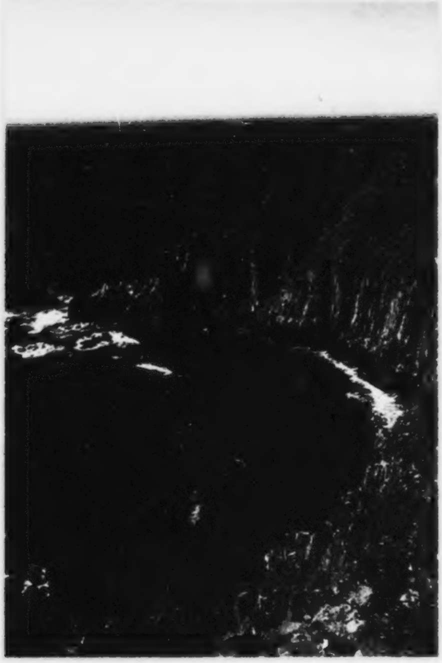
Geology

Refer to the Fundy Coast Ecoregion geology map (p. 185).

This ecodistrict contains New Brunswick's oldest and youngest rocks. The oldest rocks reach up to 900 million years old; they consist primarily of Precambrian marble, quartzite, and siltstone and occur in the Saint John area, where a marbleized limestone has been quarried for about 300 years. The youngest lithologies are Jurassic mafic volcanic rocks (mainly basalt) that are about 190 million years old and underlie much of Grand Manan Island. Collectors from across North America visit the island to gather rare minerals called zeolites, which fill vesicles in the basalt.

Precambrian volcanic rocks lie west of Fundy National Park along the coast between Point Wolfe and Salmon River, as well as in the Saint John area and on Deer Island. Granitic rocks of both Precambrian and Silurian–Devonian age are present around St.

George, the shores of Maces Bay, and around Cape Spencer.



Jurassic basalt cliffs at Southern Head, Grand Manan Island.

Sedimentary strata in this ecodistrict also span a range of geological eras. Pennsylvanian and Mississippian sandstone, conglomerate, and siltstone form the coastline east of Fundy Provincial Park. The red cliffs at St. Martins are composed of Triassic sandstone and conglomerate, whereas older, Silurian sandstone forms the Letang shoreline.

In places, the sedimentary rocks are embedded with fossils. The most famous area is Fern Ledges near Saint John, where geologists working in the 1860s collected nearly 8000 fossils from Pennsylvanian shales. The site contains fossils of insects, snails, plants, reptile footprints, and amphibian footprints. Charles Darwin mentions the site in his classic *The Descent of Man.* Just east of Fern Ledges, the Proterozoic marble deposits in Saint John contain algal stromatolites, which are among the world's oldest fossils.

Many deposits of economic mineral commodities are associated with the bedrock here, including copper, lead, gold, silver, zinc, manganese, gypsum, and building stone. In several instances, they have been commercially developed.

Landscape and Climate

The landscape here ranges from flat-lying salt marshes to high cliffs, and from the gently rolling hills of Letang Peninsula to the rugged, highly dissected shoreline of Mackerel Cove. Relief generally fluctuates between 30 m and 80 m. Overall, the area lies below 100 m in elevation except near Martin Head. There, coastal cliffs soar 300 m above the Bay of Fundy to give a stunning view of the upper bay.

The coastline features several spectacular and pristine gorges, such as at Little Salmon River, where a tributary tumbles 30 m over a cliff near the mouth of the river. Elsewhere along the coast are sea stacks, such as the Hopewell Rocks, that were formed by a combination of bedrock fracturing and differential erosion of coarse- and fine-grained sedimentary rocks. A rift cave occurs near Alma but is best left undisturbed to avoid stressing its fragile population of little brown bats and long-eared bats.

The climate is strongly influenced by cold waters of the Bay of Fundy that create moisture-laden air masses responsible for the ecodistrict's abundant precipitation and persistent fog. The bay also moderates local temperatures to produce relatively cool summers and mild winters.

Soils

The most common soils along the coast are those derived from igneous lithologies including granite, gabbro, and volcanic rocks that are generally acidic. Soils of igneous derivation are represented by the Big Bald Mountain, Juniper, and Lomond units. These stony, acidic soils occur on hills and ridges, and are shallow, non-compact, sandy loams. They are shallow and have low fertility.

The Hopewell Rocks at Hopewell Cape. In the background is the estuary of Demoiselle Creek.

Large glaciofluvial deposits of the Gagetown and Kennebecasis units are present near Pennfield Ridge and Quaco Bay. These droughty soils also have low fertility and typically support black spruce and heath vegetation or ericaceous shrubs.

The most fertile and arable lands in the area overlie zones of sedimentary rocks and tidal deposits that erode readily to create fine-textured soils of loam to clay. Examples of these soils can be found near St. Martins, Lepreau, and Cape Enrage.

Biota

The cool, wet climate has created a forest composition with many boreal elements, except for the prominence of red spruce. Forest stands on higher plateaus in the east consist almost solely of pure red spruce (5h). Elsewhere, forests comprise a mixture of red spruce with white spruce and black spruce, or balsam fir with some red maple, white birch, and yellow birch (2, 3, 5). Typically, black spruce is associated with the margins of bogs and wet areas; white spruce is the predominant spruce species in a narrow band along the shoreline and on abandoned pastures and fields. Cedar is concentrated on ridges around Saint John in areas of calcareous bedrock (7c).

The few tolerant hardwood stands contain mostly yellow birch with lesser quantities of sugar maple and beech (4, 7). What little forest exists on tidal marshes (6t) consists entirely of spruce; essentially treeless bogs (3b) also are scattered throughout the ecodistrict. Heat-loving species such as pine, hemlock, oak, ironwood, and ash are all but absent. The intolerant hardwood community that follows harvesting activities is mostly white birch with red maple, yellow birch, and grey birch. Poplar is absent from these first successional stages.

The craggy escarpment along the Point Wolfe River hosts at least three unusual plant species: glaucous meadow-grass, livelong saxifrage, and small eyebright. A tiny bog lake between Martin Head and Little Salmon River is a haven for the twining screw-stem and Oakes' pondweed. Smooth woodsia, also relatively rare, grows on calcareous cliff faces at several locations. The gorge at the Little Salmon River is one of the few New Brunswick sites with curly-grass fern.

The Fundy Coastal Ecodistrict contains Fundy National Park, two conservation areas, four nature preserves, one nature park, one ecological reserve, and three bird sanctuaries – a reflection of the ecodistrict's ecological and biodiversity significance. The nature preserves at Cape Enrage Marsh and at Saints Rest Marsh protect representative salt marshes. The latter site is crucial for migrating waterfowl and shorebirds. Together with the adjoining Irving Nature Park on Taylors Island, it has the greatest recorded diversity of bird life in New Brunswick; almost two-thirds of the province's known bird species have been seen here. Manawagonish Island Nature Preserve near Saints Rest Marsh is also an important refuge and nesting site for ducks, seabirds, cormorants, and gulls.

The Loch Alva Ecological Reserve protects a magnificent old red spruce stand and one of the deepest lakes (Loch Alva) in the province. Loch Alva supports landlocked salmon and an introduced population of lake trout. The stand is situated along the lake shore: an undisturbed, solemn acreage of trees that were seedlings when the first Loyalists set foot in New Brunswick. Immediately north of the reserve is Turtle Mountain, whose rocky summit provides a spectacular view of Saint John and the lower Bay of Fundy.

The remaining reserves include two offshore protected areas (Robert M. Stewart Nature Preserve and Machias Seal Island Migratory Bird Sanctuary), the Shepody National Wildlife Area, and the Mary's Point Ramsar Site. Mary's Point is famous across North America as a stopover point for migratory shorebirds, especially for the thousands of semipalmated sandpipers that congregate to feed on mud shrimp.

New Brunswick's offshore islands have tremendous seabird and floral significance. The outer Bay of Fundy Islands, particularly Machias Seal Island has the only known nesting site in the province for arctic tern, Atlantic puffin, and razorbill, and supports the largest puffin colony in the Maritimes. The Wolves contain one of the greatest concentrations of wintering harlequin ducks in New Brunswick. This latter species is recognized in 2001 as of Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Several other biotic features are worthy of note in the ecodistrict. A small lake in Fundy National Park is the only known New Brunswick site for the four-toed salamander. The Saint John River estuary is the only Canadian river to carry the shortnose sturgeon, which appears here at the northern extent of its range.

Gypsum deposits near Riverside-Albert were quarried for nearly 200 years but are now undisturbed by excavation. Today, they support patches of rare and disjunct arctic plants, including a species of willow, a goldenrod, and mountain avens.

The only records of long-tailed or rock shrew in New Brunswick are from talus slopes north of Riverside-Albert. Local caves are an important refuge for several bat species, including the little brown bat, long-eared bat, and eastern pipistrelle.

Settlement and Land Use

The Fundy Coastal Ecodistrict spans the traditional territories of the Mi'kmaq, Maliseet, and Passamaquoddy. Artifacts here date back to 4000 years BP, and several aboriginal settlements lived along the south coast, including in Ouigoudi at the mouth of the Saint John River. A Paleo-Indian point discovered at Quaco Head has been dated at 11,000 years old.

Many centuries ago, the Fundy coast and islands would have supported an immensely productive intertidal and tidal zone full of sea urchins, mollusks, seabirds, and seals. The native inhabitants would camp for a time at one site and deposit shellfish refuse in a mound that, when they moved on, compacted into a shell midden. Archaeological maps of the coastline west of Saint John show hundreds of midden sites, a testament to several thousand years of uninterrupted human habitation.

In the early 1600s, the lower Saint John River valley became one of the first areas in New Brunswick to be permanently settled by European immigrants. Except for the rugged terrain between Salmon River and West River, much of south coast became inhabited by people who earned earn their living as farmers, fishermen, or loggers. Then, as today, agriculture consisted primarily of mixed farming and occurred on areas of soil derived from sedimentary rock.

Many types of economic mineral commodities have been discovered and developed along the Fundy coast since the early 1800s. A partial list of formerly productive operations include graphite mines near Saint John, copper mines at Letete and Goose Creek, building stone quarries at Mary's Point and Grindstone Island, and a gold mine at Cape Spencer. The only currently active producer is a limestone aggregate quarry just east of Saint John.

Saint John has been the major settlement in the ecodistrict since before its incorporation in 1785.

A view of downtown Saint John, "The Port City". *Photograph © Ron Garnett–AirScapes.ca.*

4.1. Fundy Coastal Ecodistrict at a Glance

Ecoregion: Fundy Coast

Area: 226, 450 ha

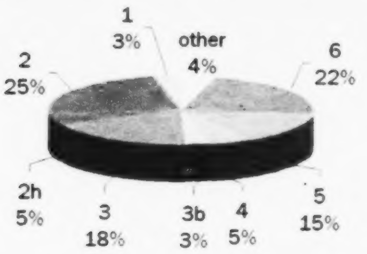
Average elevation above sea level: 84 m

Average May—September precipitation: 450—500 mm

Average annual degree-days above 5°C: 1500—1650

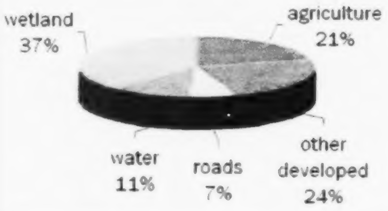
76% of Fundy Coastal Ecodistrict has forest cover

ecosite coverage of forest area

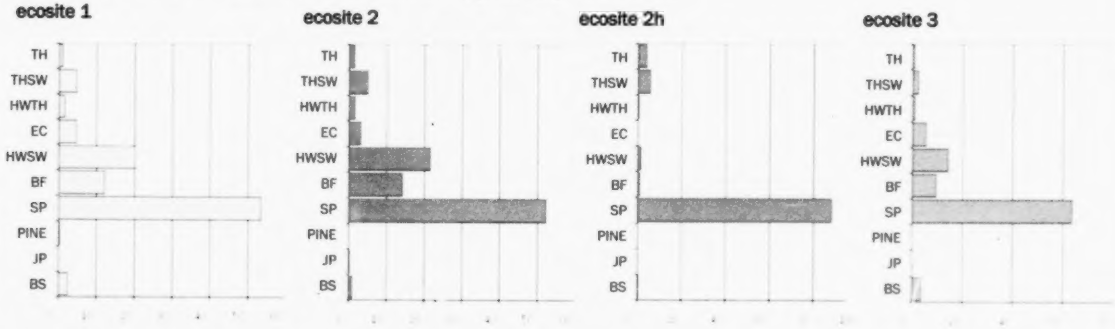


24% of Fundy Coastal ecodistrict is not forested

uses of non-forest area



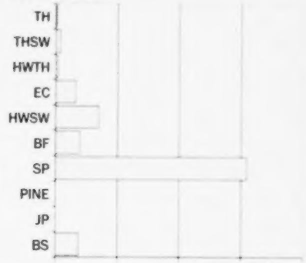
Percent cover of forest stand types by ecosite



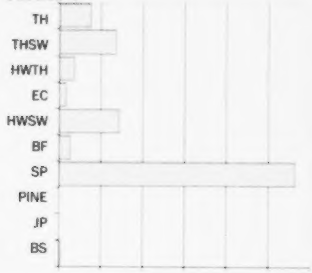
Vertical axis: TH—tolerant hardwood species; THSW—tolerant hardwood with softwood species; HWTH—intolerant hardwood and tolerant hardwood species; EC—eastern white cedar; HWSW—intolerant hardwood and softwood species; BF—balsam fir; SP—red or white spruce; PINE—white pine; JP jack pine; BS—black spruce **Horizontal axis**: percent cover.

Percent cover of forest stand types by ecosite (continued)

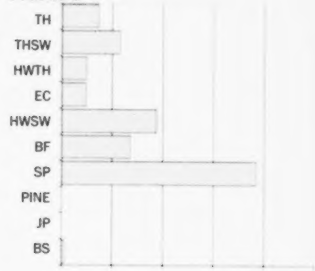
ecosite 3o



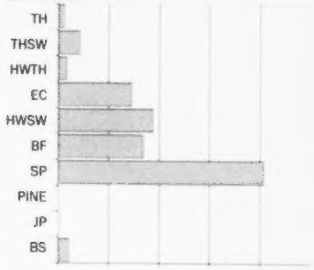
ecosite 4

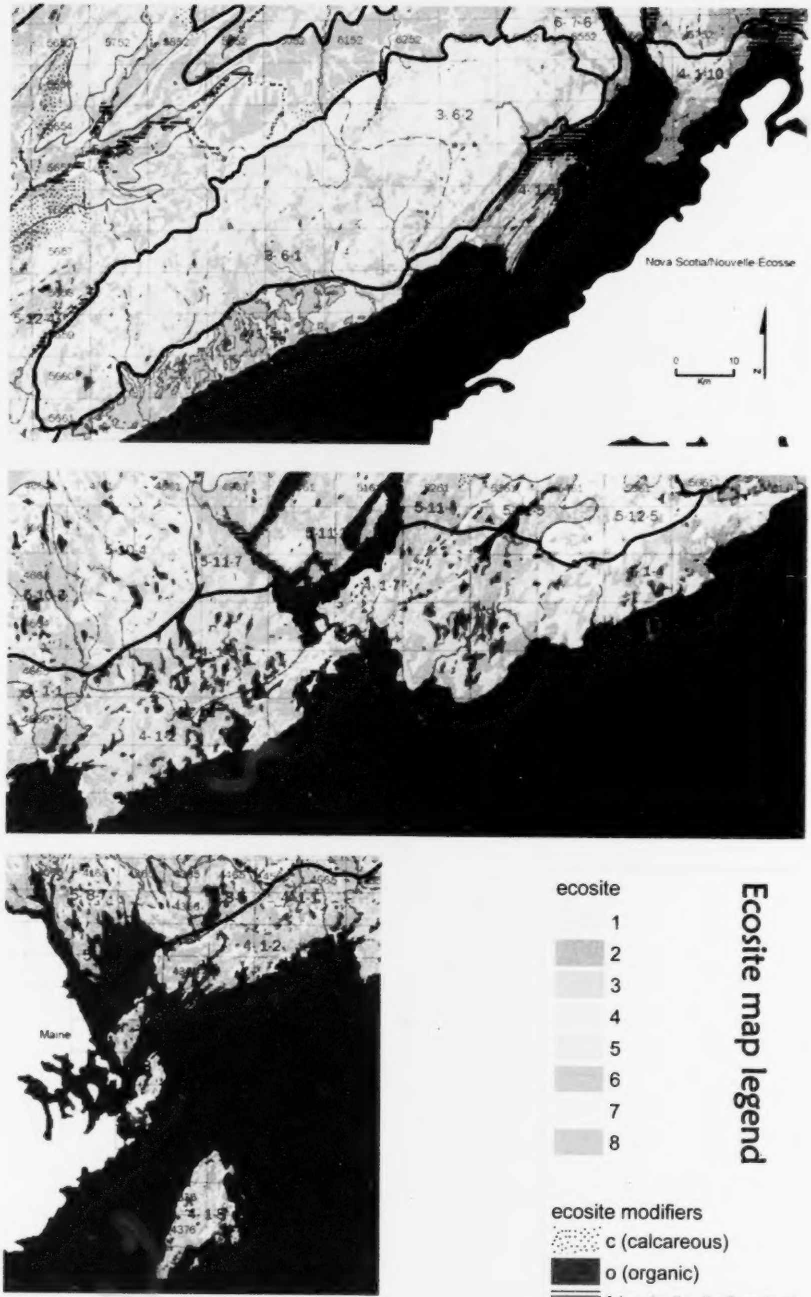


ecosite 5



ecosite 6




6·7·6
4·1·10
3·6·2
4·1·6
3·6·1
Nova Scotia/Nouvelle-Écosse
0
10
Km
N
5·11·4
5·12·5
5·10·4
5·11·7
5·11
4·1·7
4·1·2
Maine
4·1·1
4·1·2
4·1·8

Ecosite map legend

ecosite

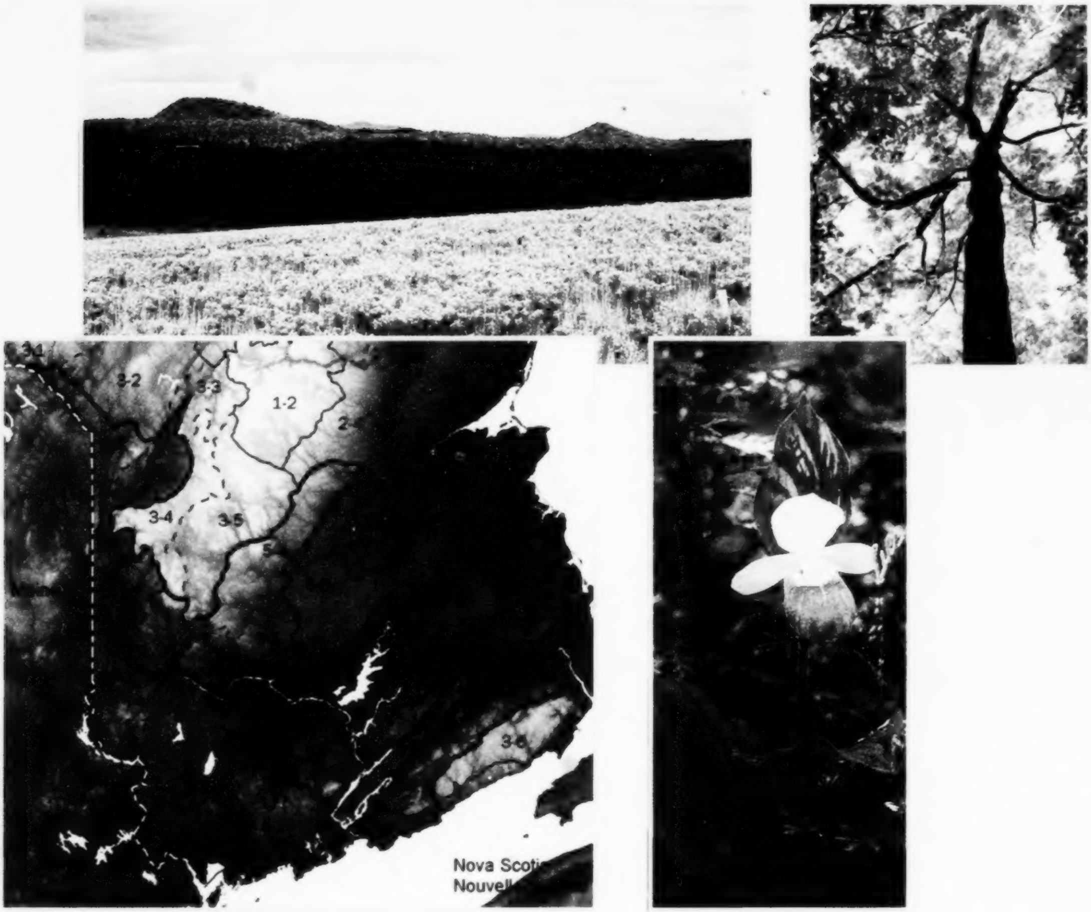
- 1
- ▨ 2
- ▨ 3
- 4
- 5
- ▨ 6
- 7
- ▨ 8

ecosite modifiers

- ▨ c (calcareous)
- ■ o (organic)
- ☰ f (periodically flooded)
- ☐ h (high elevation)
- ▨ m (mining debris)

■ water

Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce
Horizontal axis: percent cover.

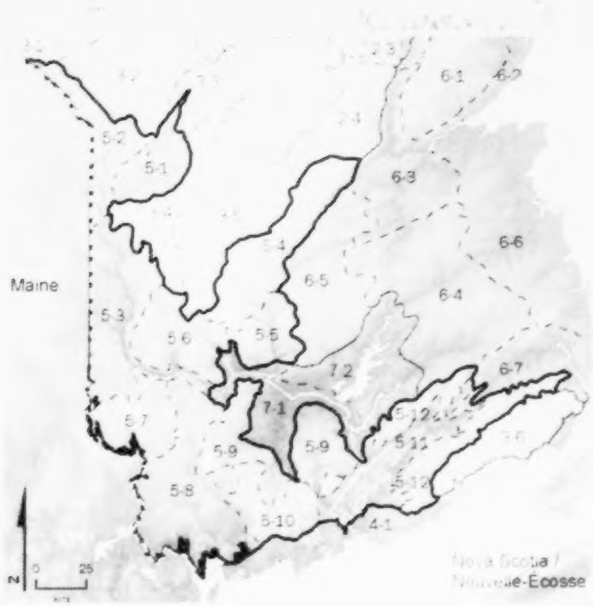


Chapter 11

5. Valley Lowlands Ecoregion

The Valley Lowlands Ecoregion includes the lower reaches of the Saint John River watershed, as well as the headwaters of several Bay of Fundy rivers. This geologically diverse area is home for many southern floral elements.

The largest of New Brunswick's ecoregions stretches from Edmundston down to Passamaquoddy Bay, and from the Maine border across almost to the Petitcodiac River. The region generally flanks the upper and middle Saint John River valley, but also includes three sinuous 'arms' that stretch northeasterly away from the valley. The defining characteristic of this region is diversity. Its geographic breadth has led to a corresponding variety of plants and animals, many with southern affinities.


5-2
5-1
5-4
5-3
Maine
5-6
5-5
6-1
6-2
6-3
6-6
6-5
6-4
7-2
6-7
7-1
5-12
5-11
5-7
5-9
5-9
5-8
5-10
4-1
5-12
N
0
25
Nova Scotia /
Nouvelle-Écosse

The Valley Lowlands Ecoregion includes the lower reaches of the Saint John River watershed, as well as the headwaters of several Bay of Fundy rivers. This geologically diverse area is home for many southern floral elements.

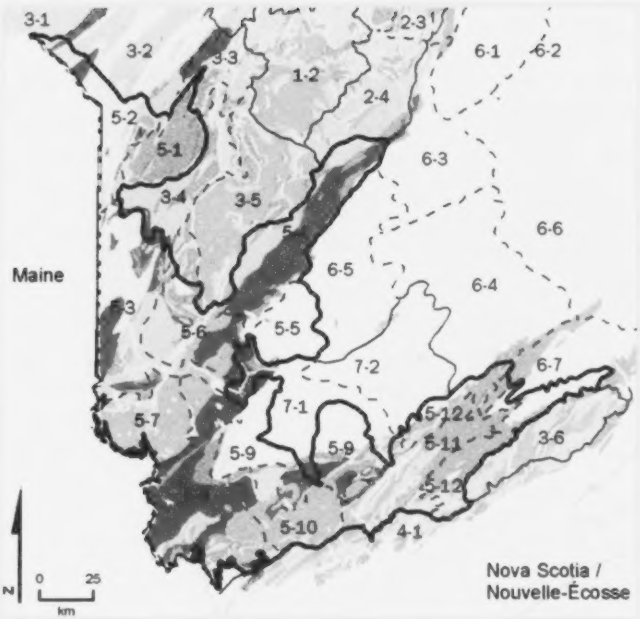
Chapter 11

5. Valley Lowlands Ecoregion

The largest of New Brunswick's ecoregions stretches from Edmundston down to Passamaquoddy Bay, and from the Maine border across almost to the Petitcodiac River. The region generally flanks the upper and middle Saint John River valley, but also includes three sinuous 'arms' that stretch northeasterly away from the valley. The defining characteristic of this region is diversity. Its geographic breadth has led to a corresponding variety of plants and animals, many with southern affinities.

Geology and Landscape

The geology of the Valley Lowlands Ecoregion is highly varied. The dominant lithology comprises sedimentary and metasedimentary rocks of Ordovician, Silurian and Carboniferous age. These are intruded by large granitic plutons that occur around Pokiok and farther south between Welsford and St. Stephen. Small, isolated patches of volcanic rocks are scattered northeast of Woodstock, southwest of Fredericton, and elsewhere.



Geology of Valley Lowlands Ecoregion

Rock Types

- Highly calcareous sedimentary
- Calcareous sedimentary
- Non-calcareous sedimentary
- Early Carboniferous sedimentary
- Late Carboniferous sedimentary
- Mafic volcanic
- Felsic volcanic
- Granites and granodiorites

The landscape's broad ridges and valleys have a strong northeast alignment that parallels the underlying trend of faults and bedrock lineaments. Highest elevations occur in the northern section, where the volcanic Cameron Mountain peaks at 572 m near New Denmark. Approaching the ecoregion's border with the basin-like Grand Lake Lowlands Ecoregion, elevation drops to about 100 m.

The Saint John River dominates the northern part of the Valley Lowlands Ecoregion, being the watershed for all lesser rivers and streams in the area. Lakes are uncommon here. By contrast, the more southerly ecodistricts, especially those underlain by granite, - are dotted by many large and small lakes. Most watercourses in this section also drain towards the Saint John River, although a few watercourses in the extreme southwest or southeast corners flow towards the Petitcodiac River or head directly into the Bay of Fundy.

Climate

This ecoregion has a continental climate that is sheltered from the maritime influences of the Northumberland and Fundy coasts. Summers are warmer and winters are colder than in areas closer to the coast.

The Highlands and Northern Uplands ecoregions also have continental climates, but the Valley Lowlands Ecoregion receives less precipitation than either of these, because of its lower elevation. It also receives somewhat less summer precipitation than either the Fundy Coast or Central Uplands ecoregions, especially in a small rain shadow area around Woodstock. The relatively warm and dry summers have contributed to a fairly high incidence of wildfires across the region. Granitic terrain appears particularly susceptible.

The undulating landscape causes cold air to drain nightly into the valleys to form frost pockets.

Forest Cover

The forest cover here is composed mainly of southern species such as tolerant hardwoods and red spruce rather than the more northerly species of balsam fir and white spruce. About thirty provincial tree species are represented here, including those with a strong southern affinity such as basswood, butternut, ironwood, silver maple, green ash, and white ash. These heat-loving species, are even more common in the Grand Lake Ecoregion, which has the warmest climate in New Brunswick.

The vegetation pattern generally reveals valleys and lower slopes covered with red spruce and other coniferous species that can withstand the cool night conditions caused by frost pockets. Cedar may occur in low-lying areas of water seepage, especially on calcareous soils. Silver maple is restricted to moist bottomlands or floodplains.

The lower midslopes are covered with mixed forests of red spruce, sugar maple, yellow birch, and white ash, which are joined farther upslope by beech and ironwood. Midslopes on coarse acidic soils may support various mixedwood communities of red pine, white pine, red oak, aspen, yellow birch, red spruce, balsam fir, and hemlock. Typically, the medium to higher elevation hilltops feature tolerant hardwoods: sugar maple, yellow birch, beech, and white ash. The rockier ridges, however, may support red oak and ironwood: on very rocky sites white pine, red spruce or white spruce predominate.

Tree harvesting and agriculture have significantly altered the original forests of this ecoregion since the 1700s. Mixed stands of white pine, tolerant hardwoods, spruce, and hemlock likely were more abundant in the distant past and to some degree, have been replaced by forest communities of aspen, red maple, white spruce, and balsam fir. White spruce and tamarack tend to occupy abandoned farmlands, whereas trembling aspen, balsam fir, red maple, and white birch occur in areas that have been clear cut or burned repeatedly.

The prominence of tolerant hardwoods through much of the region suggests that, in most places, fire has been relatively infrequent in the last several hundred years. The Anagance and Mount Pleasant ecodistricts, however, are dotted with stands of red and white pine, and of spruce. This which suggests a possibility of greater fire frequency in the past, although on some of the acidic, rocky, or coarse-textured soils, it is likely that these species are able to sustain their populations in the absence of fire. Over most of the ecoregion, understorey species are characteristic of the predominant mixed-wood environments. They include the dogtooth violet, hay-scented fern, sensitive fern, and Christmas fern. Alternate-leaved dogwood and riverbank grape are often found at the lowest elevations.

Wetlands

The Valley Lowlands Ecoregion harbours a diversity of wetland types, in keeping with the presence of its major river valleys, abundant lakes, varied bedrock lithology, and climatic variation from north to south.

Lakes are prevalent in the southerly ecodistricts, especially on the granitic terrain between Pokiok and Spednic Lake, and farther south around Mount Pleasant. Many of the lakes are flanked by marshlands, or by narrow zones of shallow open water wetlands that contain a varied collection of water-loving plants with a southern affinity such as fragrant water lily, sweet flag, and water plantain.

Of particular note is the extensive wetland complex called the Hampton-Kennebecasis Marsh that occurs between Hampton and Bloomfield along the Kennebecasis River. It is characterized by an extensive emergent marsh, but has elements of shallow open water and aquatic vegetation with some deciduous treed swamp and shrub swamp. The ecoregion's abundant peatlands are situated mainly in the southwest, where they have often formed large complexes that grade into marshes, shrub swamp, or wet forests. The wide range of peatland types occurs, not just because the substrates (and hence ground acidity levels) vary from one lithology to another, but also because the peatlands themselves have disparate origins. Some consist of raised bogs with well defined borders that formed in depressions and display many large pools. Others occur where moraine deposits (that is, extensive ridges of sand and gravel left behind by melting glaciers) have severely restricted the drainage of surface waters.

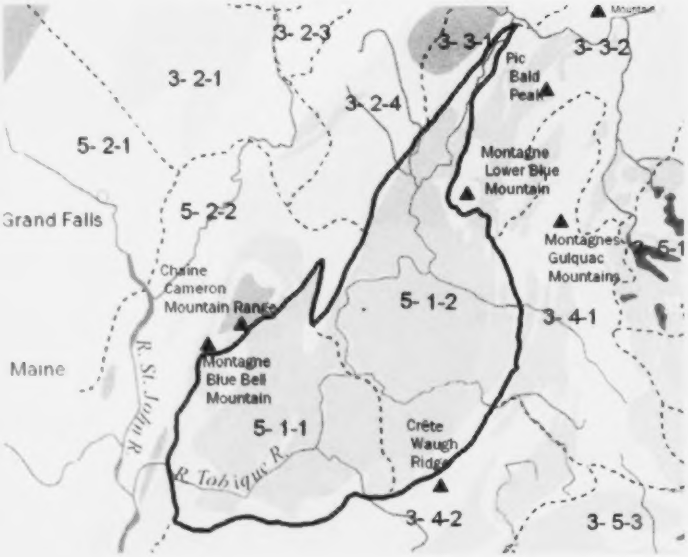
5.1. Wapske Ecodistrict

The Wapske Ecodistrict lies in northwestern New Brunswick along the lower Tobique River, and forms a low-lying basin surrounded by a series of more rugged terrains.

Geology

The bedrock consists almost solely of Devonian to Carboniferous (Mississippian to Pennsylvanian) sedimentary rocks, with a small zone of Devonian mafic volcanic rocks in the extreme northeast corner. The various formations are arranged in concentric zones that parallel the ecodistrict boundaries, with the youngest rocks at the centre.

Highway 109 between Perth-Andover and Arthurette begins in a rolling terrain of grey, folded Devonian sandstone, and slate. Approaching Arthurette, the undulating hills give way to a level plateau underlain by Carboniferous red sandstone.


3- 2-3
3- 3-1
3- 3-2
3- 2-1
Pic Bald Peak
3- 2-4
5- 2-1
Montagne Lower Blue Mountain
Grand Falls
5- 2-2
Montagnes Gulquac Mountains
5-1
Chaîne Cameron Mountain Range
5- 1-2
3- 4-1
Maine
R. St. John R.
Montagne Blue Bell Mountain
5- 1-1
Crête Waugh Ridge
R. Tobique R.
3- 4-2
3- 5-3

The immediate vicinity of Plaster Rock contains the Carboniferous limestone and gypsum deposits. They are exposed in cliffs along Highway 109 east of the Tobique River and in places are responsible for caves and karst topography.

Elsewhere, the formations comprise assorted calcareous and non-calcareous sediments: Devonian grey sandstone, siltstone and slate, plus Carboniferous red and green sandstone, conglomerate, siltstone, and shale.

Geology of Wapske Ecodistrict

Rock Types

Highly calcareous sedimentary

Calcareous sedimentary

Non-calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites

Landscape and Climate

The flat, gently sloping basin of the Wapske Ecodistrict contrasts strongly with the adjacent, more rugged igneous terrains. Its average elevation increases from 150 m in the centre to 250 m on peripheral ridges, which gives the land a saucer-like configuration.

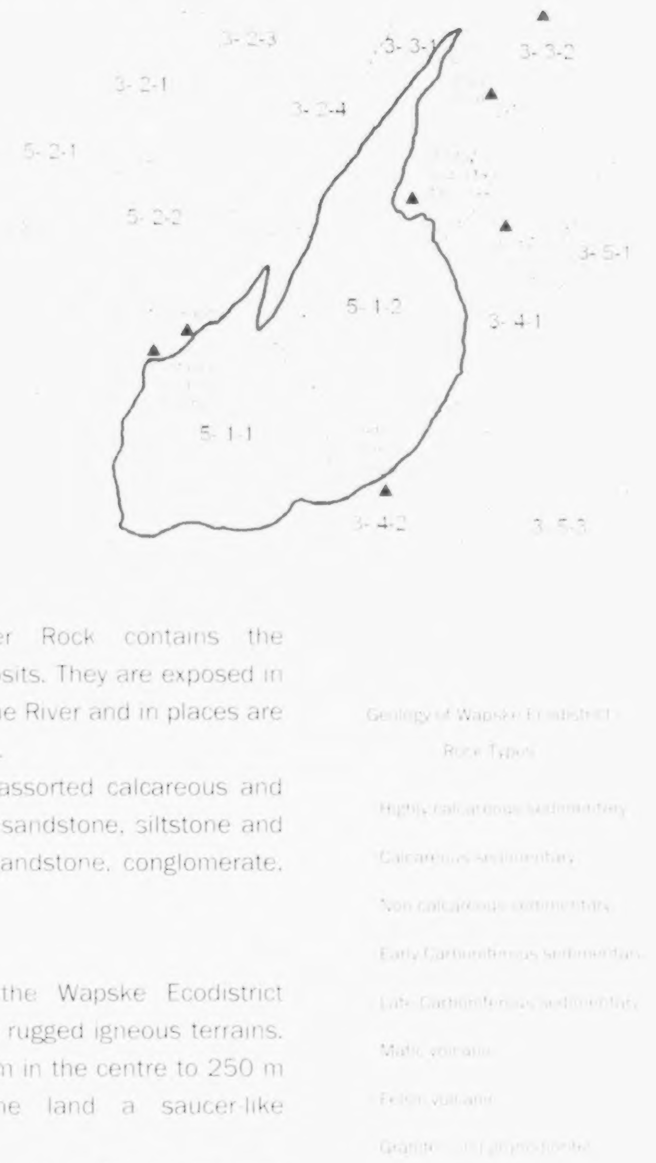
The village of Red Rapids along Tobique River derives its name from the colour of bedrock along the river.

5.1. Wapske Ecodistrict

The Wapske Ecodistrict lies in northwestern New Brunswick along the lower Tobique River, and forms a low-lying basin surrounded by a series of more rugged terrains.

Geology

The bedrock consists almost solely of Devonian to Carboniferous (Mississippian to Pennsylvanian) sedimentary rocks, with a small zone of Devonian mafic volcanic rocks in the extreme northeast corner. The various formations are arranged in concentric zones that parallel the ecodistrict boundaries, with the youngest rocks at the centre.


3- 2-3
3- 3-1
3- 3-2
3- 2-1
3- 2-4
5- 2-1
5- 2-2
3- 5-1
5- 1-2
3- 4-1
5- 1-1
3- 4-2
3- 5-3
Highly calcareous sedimentary
Calcareous sedimentary
Non calcareous sedimentary
Early Carboniferous sedimentary
Late Carboniferous sedimentary
Mafic volcanic
Felsic volcanic
Granite and granodiorite

Geology of Wapske Ecodistrict - Rock Types

Highway 109 between Perth-Andover and Arthurette begins in a rolling terrain of grey, folded Devonian sandstone, and slate. Approaching Arthurette, the undulating hills give way to a level plateau underlain by Carboniferous red sandstone.

The immediate vicinity of Plaster Rock contains the Carboniferous limestone and gypsum deposits. They are exposed in cliffs along Highway 109 east of the Tobique River and in places are responsible for caves and karst topography.

Elsewhere, the formations comprise assorted calcareous and non calcareous sediments: Devonian grey sandstone, siltstone and slate, plus Carboniferous red and green sandstone, conglomerate, siltstone, and shale.

Landscape and Climate

The flat, gently sloping basin of the Wapske Ecodistrict contrasts strongly with the adjacent, more rugged igneous terrains. Its average elevation increases from 150 m in the centre to 250 m on peripheral ridges, which gives the land a saucer-like configuration.

The village of Red Rapids along Tobique River derives its name from the colour of bedrock along the river.

The landscape is primarily one of low-lying red or grey Carboniferous sandstones, which are visible along much of Highway 23 heading north from Plaster Rock. Just before Riley Brook, a person on the highway can look northeast at the distant Devonian volcanic summit of Bald Peak in neighbouring Serpentine Ecodistrict. Immediately beside the highway is Blue Mountain, which lies on the Wapske-Serpentine ecodistrict border. The Blue Mountain range also is formed of mafic volcanics, and at 450 m is the highest peak in the ecodistrict.

The Tobique River winds through the village of Plaster Rock.

One of the more aesthetic riverine sites in the ecodistrict is Maggie's Falls on the Odellach River east of Birch Ridge, where the river cascades over small ledges into a deep narrow gorge.

The Tobique River flows southeastward through the ecodistrict and in places has eroded the terrain into fairly steep river banks. The saucer shape of the ecodistrict causes most other streams and rivers to drain inwards towards the Tobique, including the substantial Wapske and Gulguac rivers. They have incised the bedrock moderately, although the area's low relief prevents them from attaining any real speed and erosional force.

The ecodistrict possesses a drier and warmer climate than occurs in adjacent uplands to the east. Its climate shows greater similarities with the more southerly Buttermilk and Meductic ecodistricts, hence its inclusion in the Valley Lowlands Ecoregion.

Soils

Soils here are derived almost solely from slightly to moderately calcareous bedrock, with Parleeville-Tobique and Salisbury units being the most prevalent. Interspersed among the areas of highly productive soil are extensive wet areas.

A large deposit of Parleeville-Tobique soil occurs at Anfield and is composed of coarse-textured ablation till. Other areas of this unit tend to have more finely textured sandy loams to loams that occur throughout the Tobique River valley.

Deep basal tills of the Salisbury Unit are widely present, especially east of the Tobique. They are fine-textured and generally are poorly drained. Where they are moderately to well drained, however, they are the most productive in the ecodistrict and rank highly on a provincial basis.

Patchy zones of soil derived from volcanic rock occur along the ecodistrict's perimeter and belong to the Kingston, Tetagouche or Mafic Volcanic units. As well, narrow bands of Interval a soil line the Tobique River in the vicinities of Odell, Sisson Brook, and Everett.

Biota

Much of the Tobique River valley is flat or poorly drained. Poorly drained flatlands (3) consist mainly of black spruce, white spruce, red pine, and white pine, whereas the bottomland forests along the river (7b) support balsam poplar, black ash, white elm, and white spruce. Where these are very poorly drained they are dominated by black spruce and tamarack with cedar (6b). Cedar becomes more prevalent on wet sites overlying calcareous bedrock (6).

The very rare rock or yellow-nosed vole has been recorded from this ecodistrict in isolated colonies. It prefers mossy talus slopes or rocky outcrops, as found in the Tobique River valley.

The low-elevation ridgetops (8) support some areas of tolerant hardwood stands of sugar maple, yellow birch, and beech with scattered red spruce and hemlock. White ash, ironwood, and red oak are occasional components. These forests coincide with uplands rimming the ecodistrict, especially along the southeast margin, to the west of Plaster Rock and in the extreme northeast near Blue Mountain.

The Blue Mountain Ecological Reserve protects a remarkable, even-aged stand of red pine that appears to have originated after the 1825 Miramichi Fires.

Human settlement and other activities along the lower reaches of Tobique River have resulted in extensive swaths of disturbed landscape. These typically are covered with an intolerant forest community of trembling aspen, red maple, and white birch with an understorey of fir and spruce.

In places, the reddish soils of this ecodistrict are enriched with a natural source of lime, where calcareous-loving plant species may be found. The calcareous cliffs between Plaster Rock and Wapske host other rare species.

One of the most interesting wetlands in the area is protected by the Shea Lake Nature Preserve south of Plaster Rock. The site consists of an alkaline fen

The Shea Lake Nature Preserve is the home of many rare species.

with extensive stands of old growth hemlock, balsam fir and cedar. Shea Lake's plant offerings include the small round-leaved orchis, the rare Lapland buttercup, and swamp fly honeysuckle.

Settlement and Land Use

Wapske Ecodistrict lies within traditional Maliseet territory. It was used for aboriginal hunting, fishing, and overland travel, and many archaeological sites occur along the Tobique's lower reaches below Gulguac River. The Tobique River represented the initial leg in a series of aboriginal portage routes that branched from the Saint John to the Restigouche, Miramichi or Nepisiguit river systems. The name *Wapske* derived from the Maliseet *wabskihigun*, meaning *stone implements*, most likely in reference to the outcrops of felsic volcanic rock or flint that line the upper reaches of Wapske River.

Except for a few Acadian families that settled temporarily in the late 1600s, early Europeans presence in the ecodistrict focused more on logging than on establishing permanent settlements.

Timber crews began to work the Tobique River and its tributaries in earnest in the early 1800s, attracted by red and white pine covering the riverbanks and lower valley slopes. Between 1818 and 1824, timber yields from this area jumped from 7,850 to 43,460 tons, and the Wapskehegan Valley became one of most heavily felled sites in the province.

Not until 1830 did families begin to arrive from more southerly villages down the Saint John River valley, lured by rumours of plaster (gypsum) deposits and arable soil. Settlements grew slowly at first: an 1850 map of the area shows practically no habitations, and visitors reported few farms beyond sight of the Saint John River.

In time, villages slowly emerged up the Tobique, first at Red Rapids and Arthurette, the later at the more upriver communities of Mapleview and Plaster Rock. Most early residents engaged in lumbering, sawmilling and farming, or worked at the gypsum quarries in Plaster Rock.

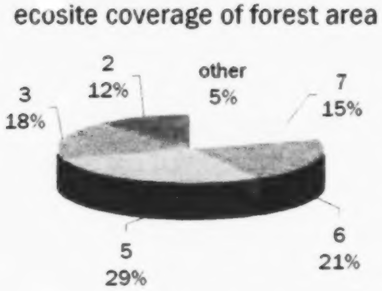
Today, forest lands are divided between industrial freehold land, private woodlots and Crown land.

Agriculture takes place over much of the arable landscape and is primarily mixed farming dominated by the production of potatoes and beef cattle. Outfitting is another significant local livelihood, as hundreds of tourists, hikers, hunters, and fishermen visit the area each year to enjoy its diverse natural and recreational offerings.

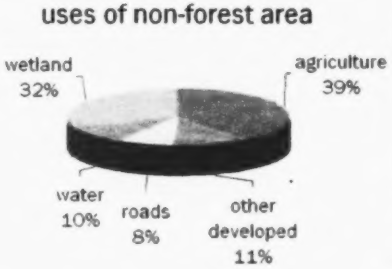
5.1. Wapske Ecodistrict at a Glance

Ecoregion: Valley Lowlands
Area: 99, 539 ha
Average elevation above sea level: 196 m
Average May—September precipitation: 475 mm
Average annual degree-days above 5 °C: 1500

86% of Wapske Ecodistrict has forest cover



14% of Wapske Ecodistrict is not forested

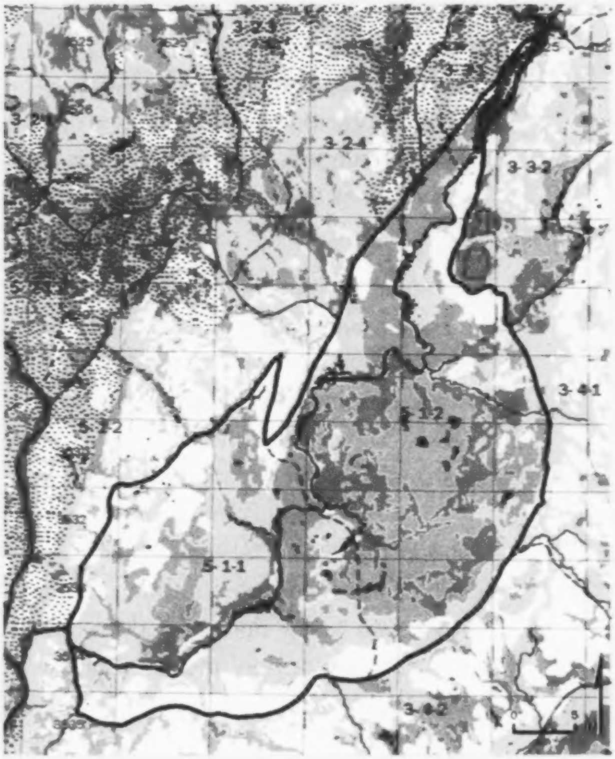


Ecosite map legend

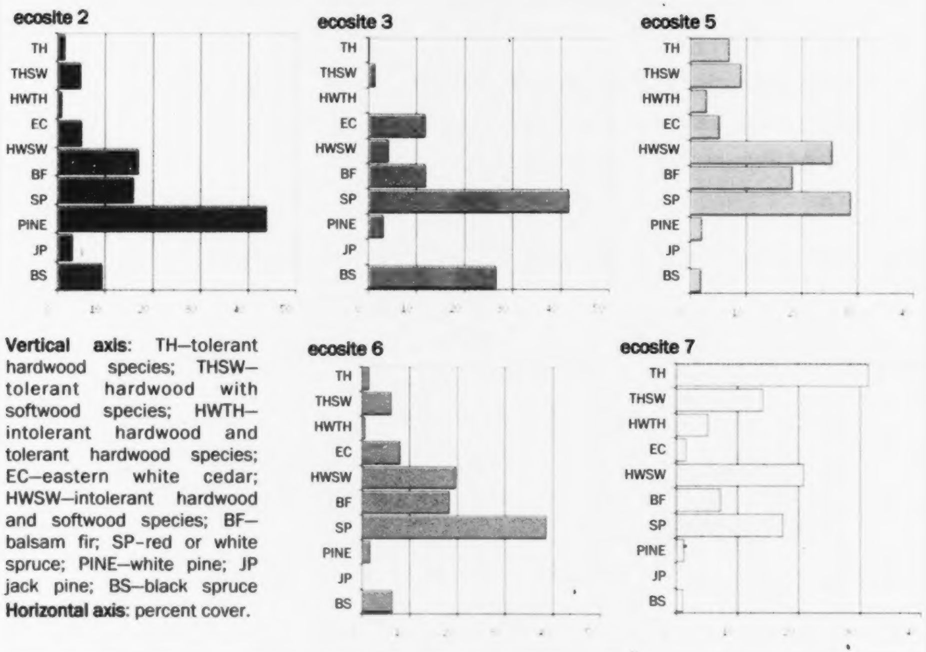
ecosite
- □ 1
- ■ 2
- ▨ 3
- □ 4
- □ 5
- ▨ 6
- □ 7
- □ 8

ecosite modifiers
- ⁘ c (calcareous)
- ■ o (organic)
- ☰ f (periodically flooded)
- □ h (high elevation)
- ⁘ m (mining debris)

■ water



Percent cover of forest stand types by ecosite



Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.

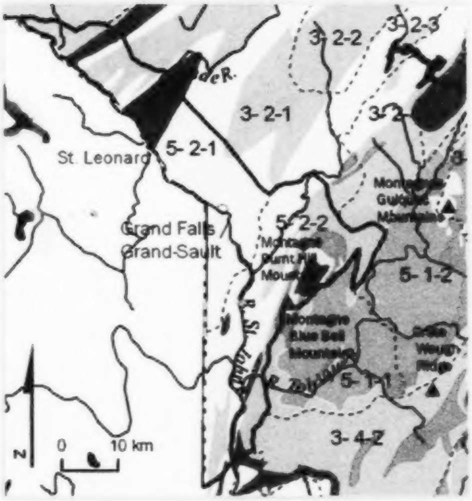
5.2. Blue Bell Ecodistrict

The Blue Bell Ecodistrict is an elongated area located on the western boundary of New Brunswick just below the panhandle, and encompasses much of the upper Saint John River Valley.

Geology

Most of the bedrock is composed of Ordovician to Silurian limestone and calcareous slate of the Matapedia Group. They are joined along the southeastern margin by narrow bands of three additional formations: Devonian grey sandstone, siltstone, and slate, steeply dipping Silurian slate and siltstone, plus Cambro-Ordovician quartzose sandstone and slate.

The only igneous rocks in the area comprise a plug of resistant Silurian mafic and felsic volcanic rocks that emerges through the Devonian sedimentary strata in the vicinities of Hazeldean and Bell Grove. Two major northeasterly-trending lineaments also intersect the geological terrain, those being the McKenzie Gulch Fault and Rocky Brook-Millstream Fault. The two geological faults have a pronounced effect upon the landscape and waterways. The Rocky Brook-Millstream Fault cuts through New Denmark, then is paralleled by Outlet Brook and Little River, before tracing part of the Saint John River below Tobique Narrows. North of Little River, the McKenzie Gulch Fault has created a strong bedrock depression that guides Salmon River.


3-2-2
3-2-3
deR.
3-2-1
3-2
St. Leonard
5-2-1
Grand Falls /
Grand-Sault
5-2-2
Montagne
Gulquac
Mountains
Montagne
Blunt Hill
Mountain
5-1-2
R. St. John
Montagne
Blue Bell
Mountain
R. Tobique
Bald
Wough
Ridge
5-1-1
3-4-2
N
0
10 km

Geology of Blue Bell Ecodistrict

Rock Types
Highly calcareous sedimentary
Calcareous sedimentary
Non-calcareous sedimentary
Early Carboniferous sedimentary
Late Carboniferous sedimentary
Mafic volcanic
Felsic volcanic
Granites and granodiorites

Landscape and Climate

The western boundary is formed by the international border, which coincides with the Saint John River north of Grand Falls. Below Grand Falls, the Saint John River edges into the middle of the ecodistrict, bisecting the glacially influenced terrain into a broad, low-lying river valley.

In areas associated with the Matapedia Group, relief generally is less than 100 m except where rivers have cut deeply into the soft calcareous bedrock such as along the Aroostook and Salmon rivers. The resistant Cambro-Ordovician quartzose rocks have produced some fairly rugged terrain near Beaconsfield, where elevations can exceed 300 m.

The most dramatic landscape occurs in the areas of mafic and felsic volcanic lithologies. These very resistant rocks underlie the southern hills around Blue Bell Mountain, Hazeldean, and the Cameron Mountain Range. The view from their ridgetops provides a splendid vista of the upper Saint John River valley, and in September their prominent slopes glow with fall colours. Cameron Mountain at 572 m is the highest point in the ecodistrict.

An immense railway viaduct straddles the McKenzie Gulch Fault at Salmon River. It is 68 m high and 1.2 km long, and is one of the longest railway viaducts in eastern Canada. A tunnel excavated through Blue Bell Mountain is the only bedrock railway tunnel in New Brunswick.

The ecodistrict's most famous landscape feature is Grand Falls. The falls were formed during and after the last glaciation through a combination of accumulated glacial sediments, gradual bedrock erosion, and gorge formation. The resulting waterfall continues to erode the bedrock surface of the upper gorge, while whirlpools below the falls create potholes on the lower gorge floor.

Soils

The most extensive soils are derived from argillaceous limestone. They consist mainly of fine-textured, non-compact tills of the Caribou Unit, with lesser amounts of compact till of the Siegas paralleled by Outlet Brook and Little River, before tracing part of the Saint John River below Tobique Narrows. North of Little River, the McKenzie Gulch Fault has created a strong bedrock depression that guides Salmon River.

Landscape and Climate

The western boundary is formed by the international border, which coincides with the Saint John River north of Grand Falls. Below Grand Falls, the Saint John River edges into the middle of the ecodistrict, bisecting the glacially influenced terrain into a broad, low-lying river valley.

In areas associated with the Matapedia Group, relief generally is less than 100 m except where rivers have cut deeply into the soft calcareous bedrock such as along the Aroostook and Salmon rivers. The resistant Cambro-Ordovician quartzose rocks have produced some fairly rugged terrain near Beaconsfield, where elevations can exceed 300 m.

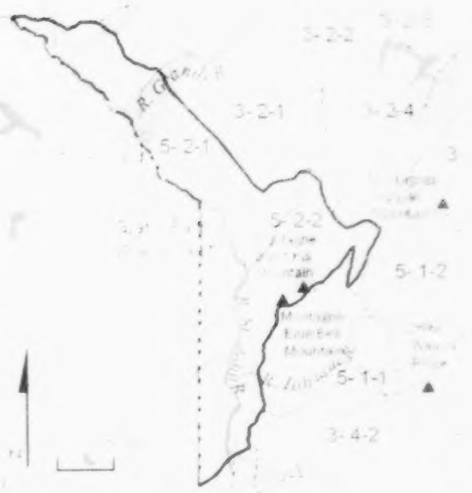
The most dramatic landscape occurs in the areas of mafic and felsic volcanic lithologies. These very resistant rocks underlie the southern hills around Blue Bell Mountain, Hazeldean, and the Cameron Mountain Range. The view from their ridgetops provides a splendid vista of the upper Saint John River valley, and in September their prominent slopes glow with fall colours. Cameron Mountain at 572 m is the highest point in the ecodistrict.

An immense railway viaduct straddles the McKenzie Gulch Fault at Salmon River. It is 68 m high and 1.2 km long, and is one of the longest railway viaducts in eastern Canada. A tunnel excavated through Blue Bell Mountain is the only bedrock railway tunnel in New Brunswick.

The ecodistrict's most famous landscape feature is Grand Falls. The falls were formed during and after the last glaciation through a combination of accumulated glacial sediments, gradual bedrock erosion, and gorge formation. The resulting waterfall continues to erode the bedrock surface of the upper gorge, while whirlpools below the falls create potholes on the lower gorge floor.

Soils

The most extensive soils are derived from argillaceous limestone. They consist mainly of fine-textured, non-compact tills of the Caribou Unit, with lesser amounts of compact till of the Siegas



Geology of Blue Bell Ecodistrict

Rock Types

Highly calcareous sedimentary

Calcareous sedimentary

Non calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites

Unit. Where the land is well drained, these soils are favourable for agriculture and forestry.

Coarse-textured glaciofluvial deposits line parts of the Saint John, Salmon, and Grande rivers, and are represented by the Muniac or Grand Falls units. Soils derived from metasedimentary rocks cover the ridges and hills around Beaconsfield. These materials appear either as shallow, residual soils of the Glassville Unit, or as medium-textured, compact soils of the Holmesville Unit.

Biota

Mixed forest communities cover much of the lower slopes (5), whereas coniferous communities composed mainly of cedar with some spruce are restricted to poorly drained soil derived from limestone, calcareous, and non-calcareous sedimentary rocks (6l, 6c, 6). The area of Burnt Hill Mountain contains a cedar swamp and rich calcareous woods with a delicate understorey that includes the rare pale touch-me-not. For the most part, tolerant hardwood communities cap the hilltops except at Cameron Mountain southeast of New Denmark, where a hardwood forest grows at the base, grading upslope into a stunted coniferous forest at the summit.

Tree species with a southern affinity such as white ash, ironwood, butternut, and basswood occur in the Meductic Ecodistrict immediately to the south, but are less common in this slightly cooler region. The Salmon River mouth, however, is somewhat anomalous in that it hosts butternut and silver maple, a plant assemblage that more typically appears farther south. The rivermouth also hosts elements of the herbaceous layer more common in the southern part of the province: species such as calico aster, white snakeroot, and climbing false buckwheat. The forest cover and understorey thus reflect the position of this ecodistrict as the most northern extension of the Valley Lowlands Ecoregion.

Mature pine stands are scarce. Intolerant hardwood species consisting mainly of trembling aspen and large-toothed aspen with white birch are common on former farming sites along the Saint John and Salmon rivers. White spruce, cedar, and tamarack also have regenerated on old-field sites.

As with the adjacent Wapske Ecodistrict, the extensive calcareous soils here are have encouraged the growth of several rare or uncommon plants. The dynamics of the Saint John River, with its large spring freshet and ice scour, also contribute to the creation of unique habitats for rare species. The most famous of these is Furbish's lousewort. This plant is a member of the snapdragon family and occurs at only a few sites, including the George Stirrett Nature Preserve, which is maintained by the Nature Trust of New Brunswick. The populations from the upper Saint John River valley in New Brunswick and Maine are the world's only known populations of Furbish's lousewort. It is recognized as nationally endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and the species and its habitat are protected under the provincial Endangered Species Act.

The village of Rivière Verte lies just downriver from Edmundston. The river here separates Maine, USA, from New Brunswick. The hills in the distance are in the Central Uplands Ecoregion. *Photograph © Ron Garnett--AirScapes.ca.*

The wide, northerly reaches of the Saint John River are characterized by floodplains, alluvial islands, and oxbows that support an assemblage of plants and also provide habitat for migratory and nesting birds. Bluestem and Richardson's muhlenbergia grow on Quisibis Island above the Quisibis River mouth. The site receives migrating waterfowl in the spring and autumn, as does the mouth of the Green River a few km north. Colourful swaths of tiger lily, an introduced asiatic lily, also grow on the floodplain at the mouth of the Green River, which joins the Saint John River at the village of Rivière Verte

The most frequented migratory bird locations here are at Iroquois (which lies adjacent to the nutrient-rich wastewater treatment plant for Edmundston) and Platin de St-Basile. The southern tip of the St-Basile platin is one of the larger undisturbed floodplains in the upper Saint John River valley.

Settlement and Land Use

This ecodistrict lies in traditional Maliseet territory. An important Maliseet community named *Negookgoot* occurred at the confluence of the Tobique and Saint John rivers near the present-day Maliseet village. The Saint John River valley above and below the Tobique River also supported numerous early aboriginal encampments.

The original non-aboriginal inhabitants were Acadians who began to arrive in the late 1600s. Timber crews frequented the area in the early 1800s, followed by Acadian and second-generation Loyalist families from southern New Brunswick who established villages such as St-Léonard, Perth, and Andover. An 1850 visitor reported that the river valley area between Andover and Grand Falls was virtually uninhabited except at the Aroostook confluence, but that French and Irish settlements were plentiful above the Quisibus River.

Subsequent immigrants arrived from Britain and Denmark (hence the villages of Hazeldean and New Denmark), and the province of Québec. The main sources of prosperity in the region were agriculture, sawmills, logging, and woodworking, all of which received an economic boost with the arrival of the New Brunswick Railway in 1877. By the turn of the century, the annual log drive over Grand Falls was a popular event initiated by Main John Glasier, the first man to run a load of timber over the falls. Grand Falls originally fell in a spectacular plunge of nearly 40 m, but was much tamed by the construction of a hydroelectric dam in the late 1920s.

Forest lands in the area belong almost solely to non-industrial woodlot owners. The forest industry remains a mainstay of the local economy, along with other forest-based activities.

Agricultural activities revolve around the production of potatoes and other crops, and a large processing plant in Grand Falls.

5.2 Blue Bell Ecodistrict at a Glance

Ecoregion: Valley Lowlands

Area: 125, 028 ha

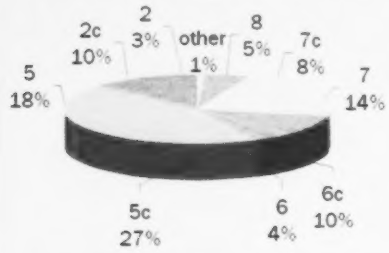
Average elevation above sea level: 219 m

Average May–September precipitation: 450–475 mm

Average annual degree-days above 5°C: 1550–1650

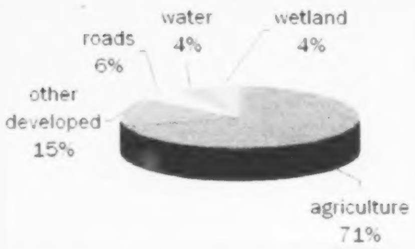
64% of Bluebell Ecodistrict has forest cover

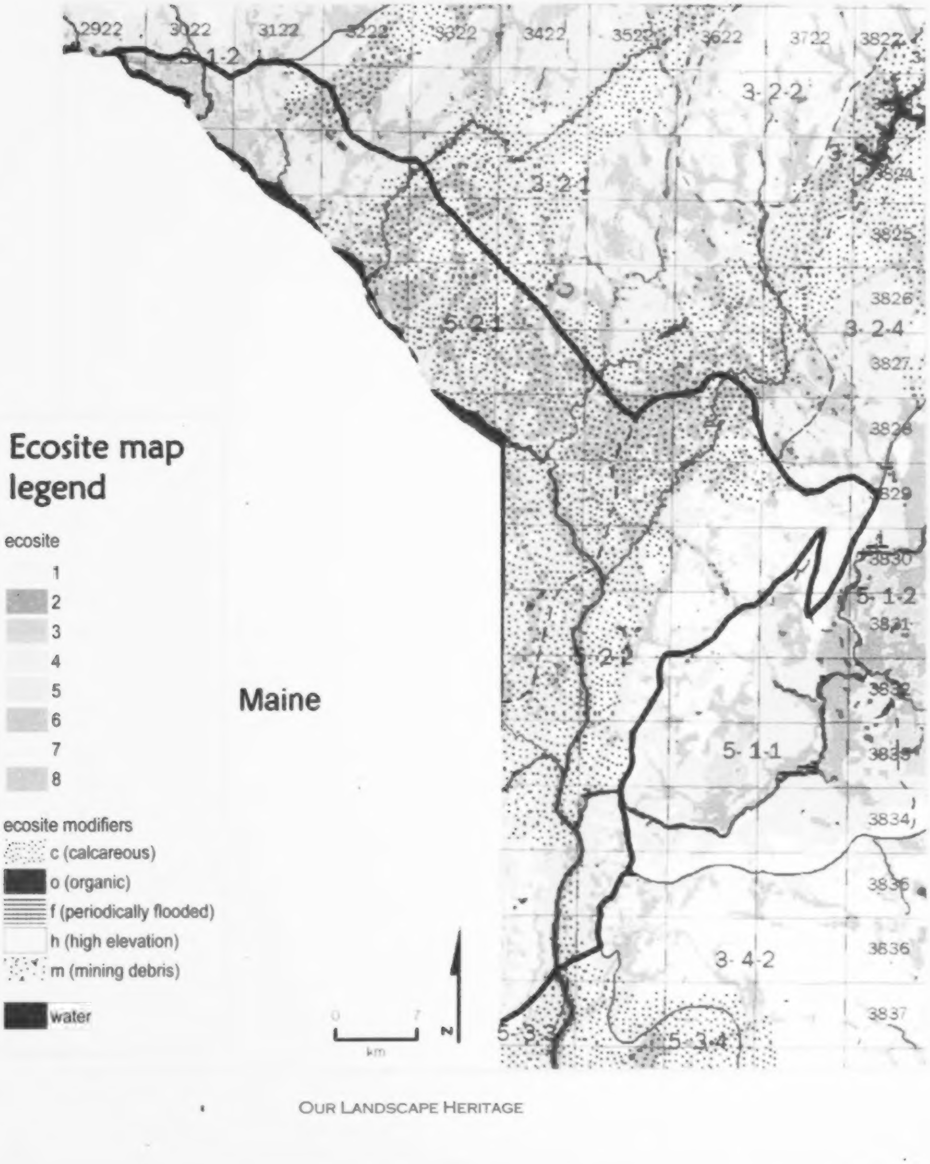
ecosite coverage of forest area



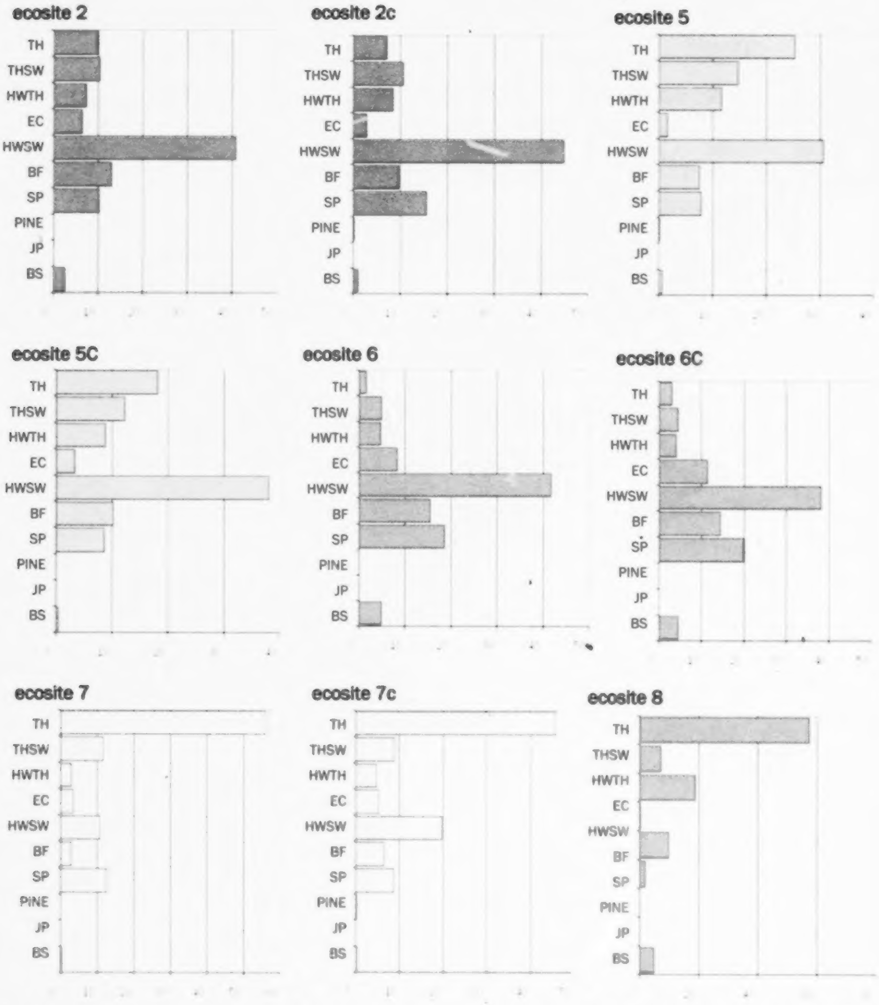
36% of Bluebell Ecodistrict is not forested

uses of non-forest area




2922
3022
3122
3222
3322
3422
3522
3622
3722
3822
3-1-2
3-2-2
3-2-1
5-2-1
3-2-4
3825
3826
3827
3828
3829
3830
5-1-2
3831
3832
3833
3834
3835
3836
3837
2-2
5-1-1
3-4-2
5-3-3
5-3-4
Maine
Ecosite map legend
ecosite
1
2
3
4
5
6
7
8
ecosite modifiers
c (calcareous)
o (organic)
f (periodically flooded)
h (high elevation)
m (mining debris)
water
0
7
km
N

Percent cover of forest stand types by ecosite



Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.

5.3. Meductic Ecodistrict

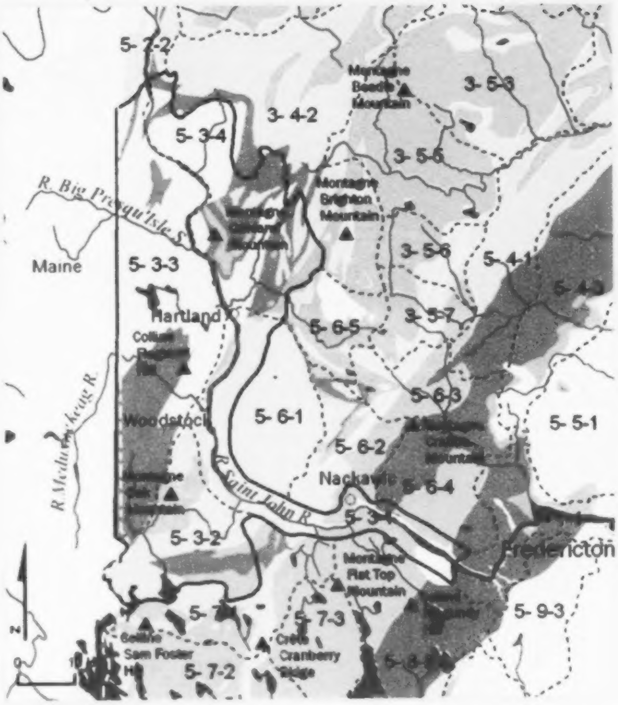
The Meductic Ecodistrict is a gently rolling lowland area that encompasses the middle Saint John River valley between Kilburn and Prince William.

Geology

Bedrock here is divided into three sections that straddle the Saint John River. The northern section lies upriver from Hartland, the second section stretches from Hartland to Middle Southampton, and the third runs downriver from Middle Southampton to Prince William.

Bedrock in the northern section consists primarily of Ordovician calcareous sedimentary rocks that include slate and limestone of the Matapedia Group. The middle section is manifested as a fault-bound wedge of Ordovician sedimentary strata, which narrows as it approaches the Maine border. Rocks within the wedge are dominated by greywacke, slate, and siltstone of the Tetagouche Group, and are slightly calcareous.

The southernmost section is underlain by Devonian granitic rocks that can be seen in numerous highway roadcuts between Nackawic and Pokiok. Small intrusions and plugs of Ordovician to Devonian mafic and felsic igneous rocks also appear throughout the ecodistrict, and tend to be more resistant to erosion than the surrounding sedimentary strata.


5-7-2
3-4-2
Montagne Beadle Mountain
3-5-3
5-3-4
3-5-5
R. Big Presqu'Isle S.
Montagne Brighton Mountain
3-5-6
5-4-1
5-4-3
Maine
5-3-3
Hartland
5-6-5
3-5-7
R. Meduxnekeag R.
5-6-3
5-6-1
5-5-1
Woodstock
5-6-2
Nackawic
5-6-4
R. Saint John R.
5-3-1
5-3-2
Fredericton
Montagne Flat Top Mountain
5-7-3
5-9-3
Sam Foster Hill
5-7-2
Cranberry Ridge
N

Geology of Meductic Ecodistrict

Rock Types

Highly calcareous sedimentary

Calcareous sedimentary

Non-calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites

Landscape and Climate

The dominant geographic feature is the expansive Saint John River. Its broad river valley has a pastoral appearance, reflecting the underlying calcareous bedrock and associated arable soils. The ecodistrict's western border coincides with the international boundary, and the northeastern edge is buttressed by more rugged terrain of the adjoining Serpentine Ecodistrict.

Relief of the gently rolling landscape rarely exceeds 100 m, and is punctuated by small intrusions of resistant bedrock, which underlie several local hills and mountains. An isolated plug of

5.3. Meductic Ecodistrict

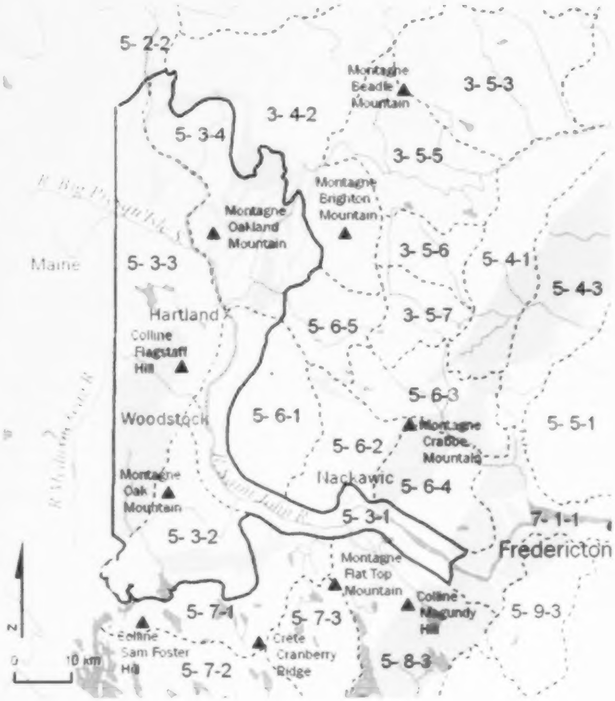
The Meductic Ecodistrict is a gently rolling lowland area that encompasses the middle Saint John River valley between Kilburn and Prince William.

Geology

Bedrock here is divided into three sections that straddle the Saint John River. The northern section lies upriver from Hartland, the second section stretches from Hartland to Middle Southampton, and the third runs downriver from Middle Southampton to Prince William.

Bedrock in the northern section consists primarily of Ordovician calcareous sedimentary rocks that include slate and limestone of the Matapedia Group. The middle section is manifested as a fault-bound wedge of Ordovician sedimentary strata, which narrows as it approaches the Maine border. Rocks within the wedge are dominated by greywacke, slate, and siltstone of the Tetagouche Group, and are slightly calcareous.

The southernmost section is underlain by Devonian granitic rocks that can be seen in numerous highway roadcuts between Nackawic and Pokiok. Small intrusions and plugs of Ordovician to Devonian mafic and felsic igneous rocks also appear throughout the ecodistrict, and tend to be more resistant to erosion than the surrounding sedimentary strata.


5-2-2
3-4-2
Montagne Beadle Mountain
3-5-3
5-3-4
3-5-5
Montagne Brighton Mountain
Montagne Oakland Mountain
Maine
5-3-3
3-5-6
5-4-1
5-4-3
Hartland
3-5-7
5-6-5
Colline Flagstaff Hill
5-6-3
Woodstock
5-6-1
Montagne Crabbe Mountain
5-5-1
5-6-2
Montagne Oak Mountain
Nackawic
5-6-4
Saint John R.
5-3-1
7-1-1
5-3-2
Fredericton
Montagne Flat Top Mountain
Colline Nasgundy Hill
5-9-3
5-7-1
5-7-3
Colline Sam Foster Hill
Crete Cranberry Ridge
5-8-3
5-7-2
N
0
10 km

Geology of Meductic Ecodistrict

Rock Types

- Highly calcareous sedimentary
- Calcareous sedimentary
- Non-calcareous sedimentary
- Early Carboniferous sedimentary
- Late Carboniferous sedimentary
- Mafic volcanic
- Felsic volcanic
- Granites and granodiorites

Landscape and Climate

The dominant geographic feature is the expansive Saint John River. Its broad river valley has a pastoral appearance, reflecting the underlying calcareous bedrock and associated arable soils. The ecodistrict's western border coincides with the international boundary, and the northeastern edge is buttressed by more rugged terrain of the adjoining Serpentine Ecodistrict.

Relief of the gently rolling landscape rarely exceeds 100 m, and is punctuated by small intrusions of resistant bedrock, which underlie several local hills and mountains. An isolated plug of

Ordovician mafic volcanic rocks just west of Benton, is expressed locally as Oak Mountain and Sugarloaf Mountain. Oakland Mountain southeast of Florenceville is underlain by Silurian mafic volcanic rocks.

Hartland, New Brunswick boasts the world's longest covered bridge. Here the Becaguimec Stream meets the Saint John River. *Photograph © Ron Garnett–AirScapes.ca.*

Numerous rivers drain into the Saint John River from the surrounding uplands beyond the ecodistrict. The Eel River wends its way from First Eel Lake over nearly half a dozen different rock types, then forms a sequence of rapids before entering the Saint John River at Meductic. Some rivers flow easily towards their watershed destination, but others arrive from higher ground in a flurry of turbulent water. The early Maliseet marked this aspect of Meduxnekeag River by naming it *medukseneekik* meaning '*rough at its mouth*'.

First Eel Lake is one of the largest in the ecodistrict, and is first in a string of lakes that stretch southward beyond the ecodistrict through to Spednic Lake and the St. Croix river system. Williamstown Lake west of Hartland is bigger than First Eel, but is so shallow that it is more like a wetland than a lake. Moose Lake lies in the northern part of the ecodistrict and, like White Mud Lake, is covered on its bottom with lime-rich marl deposits. White Mud Lake east of Maplehurst currently produces marl on a seasonal basis. The lake is the only active marl producer in the Maritimes.

The distinctive character of this ecodistrict results in part from its relatively dry, warm climate combined with rich calcareous soils. Its precipitation is lower than in the adjacent Central Uplands Ecoregion, and its lengthy growing season is second only to that of the even warmer Grand Lake Ecoregion.

Soils

Soils derived from the widespread calcareous bedrock dominate the ecodistrict. Soils formed from limestone are associated with the Undine, Siegas and Caribou units. They are slightly more fertile than materials derived from weathered calcareous siltstone, slate, or sandstone such as those of the Carleton and Muniac units.

Non-compact soils of the Caribou Unit cover much of the terrain. These well drained, deep, loamy soils contain easily crushed, weathered shale fragments and are among the most fertile soils in New Brunswick. Relatively shallow, bedrock-derived residual soils of the Undine Unit are common, and compact basal tills of the Siegas Unit also are present locally.

Coarse-textured glaciofluvial deposits of the Muniac Unit line the Saint John River valley and some of its tributaries such as Monquart Stream. The Carleton Unit is similar to the Caribou Unit but is more compact at depth; it is predominant around Woodstock and Florenceville.

Biota

The original forest cover has been greatly disturbed by more than two centuries of dense settlement. Tolerant hardwood stands once dominated the area but now exist only as small woodlot oases in a widespread agricultural matrix. The few undisturbed ridgetops at low elevation support sugar maple and beech with white ash, ironwood, butternut, and basswood. These communities grade downslope (7c) into a mixed forest of sugar maple, balsam fir and beech. Caribou Unit soils in particular tend to support good-quality sugar maple and white ash stands.

Red spruce and hemlock generally are confined to steep slopes (4). Hemlock also occurs with hardwood, as on a forested slope between Lanes Creek Inlet and Phillips Flats just north of Upper Woodstock.

The flooded alluvial bottomlands (7b) located in the Eel River valley contain butternut and basswood, whereas calcareous, poorly drained flatlands (6c) are characterized by cedar stands such as occur at Payson Lake and Williamstown Lake. The latter location is dominated by cedar with black ash, red maple, and white elm.

Agricultural fields and roads have fragmented the landscape, so that it has an historically low frequency and size of fires, despite relatively dry summers. Consequently, pines are rare, whereas white spruce and tamarack reveal the location of many old-field sites. Intolerant hardwood species consist mainly of trembling aspen and large-tooth aspen with birch, and are restricted to abandoned farmlands.

A hardwood stand near Murphy Corner contains one of the few known Canadian sites for the moss *Entodon brevisetus*. It grows on the trunks of tolerant hardwoods such as sugar maple and ironwood.

The combination of widespread calcareous soils, warm climate, and diverse (although much reduced) stands of tolerant hardwoods has given the Meductic Ecodistrict one of the richest arrays of unusual plants in the province. As much of the original forest has been either converted to agriculture or flooded by hydroelectric dam projects, several elements, especially understorey plants have become scarce. Canada violet, which may have been extirpated from Nova Scotia and is almost gone from Maine, appears at several sites near Woodstock. Showy orchis grows beneath mature hardwood stands on the banks of the Meduxnekeag River, along with yellow lady's-slipper, maidenhair fern and Goldie's fern. Rareties such as ten-rayed sunflower and sweet viburnum may also be found along the shores and bottomlands of the ecodistrict.

Ketch Lake southwest of Charleston hosts an albino version of the small purple-fringed orchis and also is a haven for the rare Clayton's or Dorcas copper butterfly, which relies on shrubby cinquefoil for larval food. Visitors to beech stands in the ecodistrict may witness another rare butterfly–the early hairstreak–which lays its eggs on beech nuts.

Prime remnants of the forest type that once covered much of the ecodistrict can still be found. Oak Mountain Ecological Reserve sits 120 m above the surrounding terrain and protects a community dominated by sugar maple, beech, white ash, ironwood and basswood. A similar mature hardwood stand lies northeast of Howard Brook near Skedaddle Ridge. In spring, the site displays a prismatic understorey of Dutchman's breeches, bloodroot, spring beauty, Selkirk's violet, smooth yellow violet, red trillium, and foamflower.

At Williamstown Lake, wetlands provide important habitat for waterfowl. First Eel Lake has also hosted notable bird species, with nesting loons, bald eagle, osprey, scarlet tanager, wood duck and pied-billed grebe.

The ecodistrict is one of the primary breeding areas for scarlet tanager, warbling vireo, and wood thrush in the Maritimes.

Settlement and Land Use

The ecodistrict lies within traditional Maliseet territory, and has been inhabited by aboriginals for at least the last 3500 years. A major native village located near present-day Meductic was strategically situated along the Eel River portage one of the most ancient and well used overland routes between the Saint John River valley, Passamaquoddy Bay, and New England. Another important village occurred near present-day Bristol.

Canoeists following the Eel River portage hiked inland from Meductic and entered Eel River at Benton. They paddled upriver to First Eel Lake and from there proceeded along another portage to North Lake, which empties into Grand Lake on the St. Croix river system. From Grand Lake, they could travel either west to Penobscot and Kennebec country in Maine via Penobscot River, or continue southward along the turbulent St. Croix River to Passamaquoddy Bay.

Meductic derives from the Maliseet word *medoctic* meaning '*the end*', referring to the Eel River-Saint John confluence being the end of the Eel River-Passamaquoddy portage.

Early non-aboriginal settlers lived almost exclusively along the shores of Saint John River rather than inland. The first wave of immigrants in the late 1700s consisted of Loyalists and pre-Loyalists dissatisfied with their original, more southerly New-Brunswick land grants. The end of the Napoleanic wars brought a second wave of newcomers in the early 1800s: mainly Scots, Irish, English, and disbanded soldiers.

Settlers relied mainly on agriculture, logging, and mining for their livelihood, and used Woodstock as the commercial hub. The completion of two major railway lines from southern New Brunswick through Woodstock in the 1860s and 1870s put an end to the romantic Saint John River steamboat expeditions, but expanded local economic development.

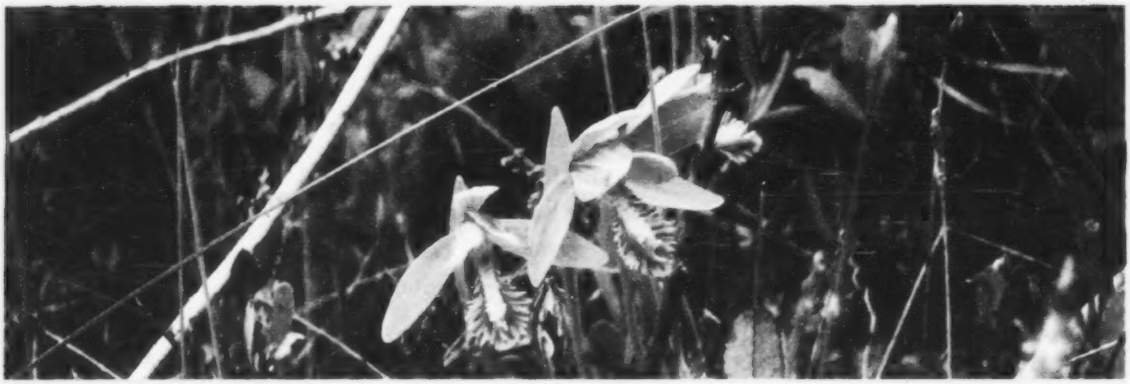
Remnants of an early grist mill can still be seen where Summit Brook crosses Scotch Lake Road about 1 km from Route 105. The mill was powered by a waterfall on the brook.

Deposits of iron, marl, gold, silver, lead, copper, limestone, and manganese were discovered here during the 19th century, although not all were developed. The largest operation was an iron mine and smelter near Jacksonville that worked from 1848 to 1884 .

Agricultural activities occupy about 32% of the total land area and are situated mainly over soils of the Caribou Unit. The predominant cash crop of potatoes is planted in rotation with grain; livestock and dairy operations round out the mixed farming activities.

Forest lands in the area today consist almost entirely of non-industrial woodlots and Crown land.

The confluence of the Meduxnekeag and Saint John rivers occurs at Woodstock, New Brunswick. *Photograph © Ron Garnett–AirScapes.ca.*



The wetlands of Meductic Ecodistrict are known for their exceptional plant diversity which includes orchids such as rose pogonia.

5.3 Meductic Ecodistrict at a Glance

Ecoregion: Valley Lowlands

Area: 250, 306 ha

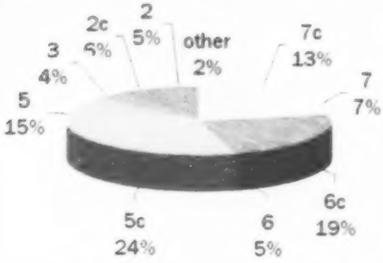
Average elevation above sea level: 159 m

Average May–September precipitation: 400–450 mm

Average annual degree-days above 5 °C: 1500–1600

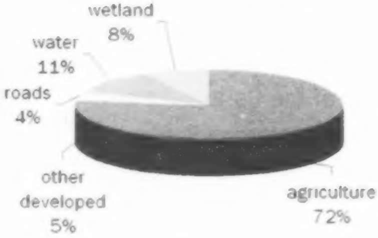
65% of Meductic Ecodistrict has forest cover

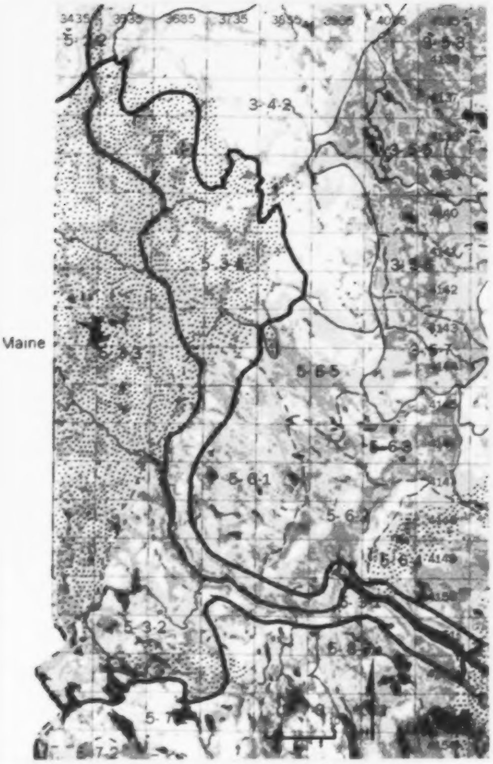
ecosite coverage of forest area



35% of Meductic Ecodistrict is not forested

uses of non-forest area




3435
3685
3735
5-4-2
3-4-2
3-3-5
4140
3-3-6
4142
4143
3-5-7
5-3-4
Maine
5-3-3
5-6-5
5-6-3
5-6-1
5-6-2
5-6-4
4149
5-3-2
5-6-7
5-7
5-7-2

Ecosite map legend

ecosite

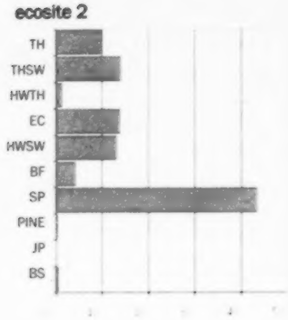
1
▨ 2
▨ 3
4
5
▨ 6
7
▨ 8

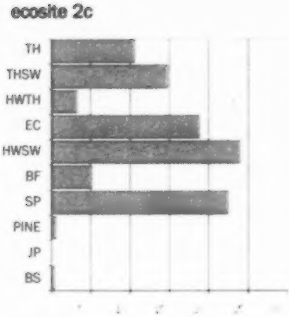
ecosite modifiers

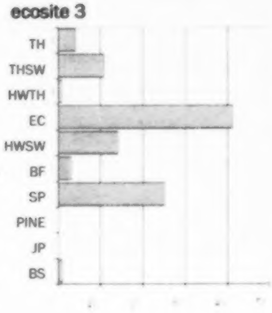
▨ c (calcareous)
■ o (organic)
▤ f (periodically flooded)
☐ h (high elevation)
▨ m (mining debris)

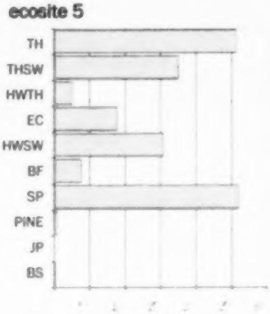
■ water

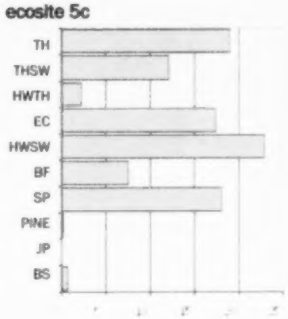
Percent cover of forest stand types by ecosite

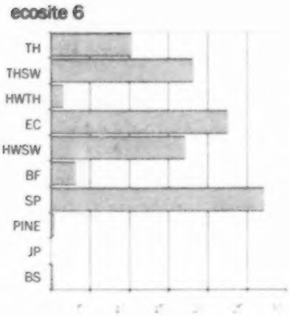

ecosite 2

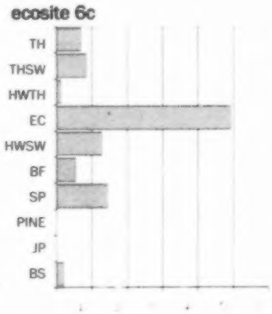

ecosite 2c

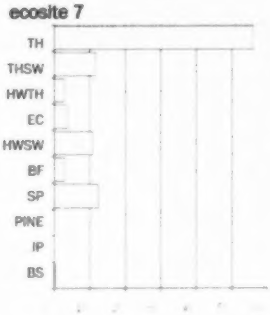

ecosite 3

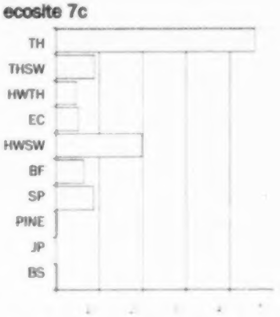

ecosite 5


ecosite 5c

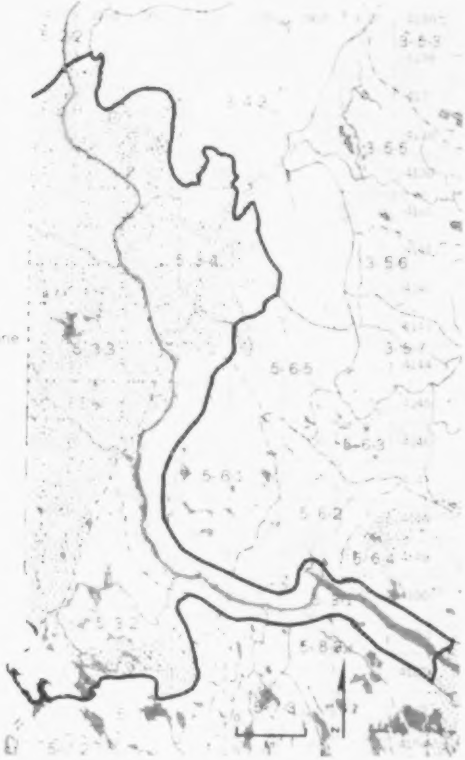

ecosite 6


ecosite 6c


ecosite 7


ecosite 7c

Vertical axis: TH—tolerant hardwood species; THSW—tolerant hardwood with softwood species; HWTH—intolerant hardwood and tolerant hardwood species; EC—eastern white cedar; HWSW—intolerant hardwood and softwood species; BF—balsam fir; SP-red or white spruce; PINE—white pine; JP jack pine; BS—black spruce **Horizontal axis**: percent cover.



Ecosite map legend

ecosite

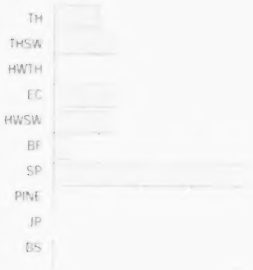
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

ecosite modifiers

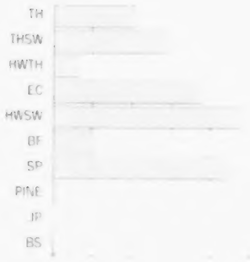
- ▨ c (calcareous)
- ■ o (organic)
- ≡ f (periodically flooded)
- h (high elevation)
- ⁘ m (mining debris)
- ■ water

Percent cover of forest stand types by ecosite

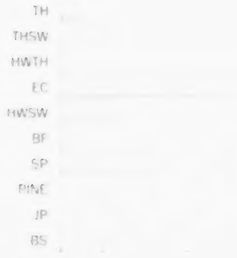
ecosite 2



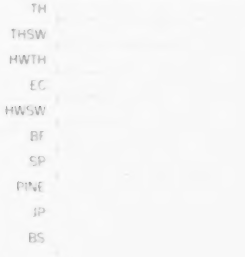
ecosite 2c



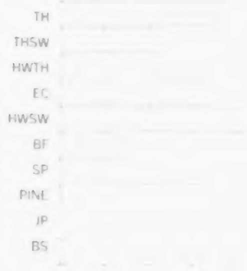
ecosite 3



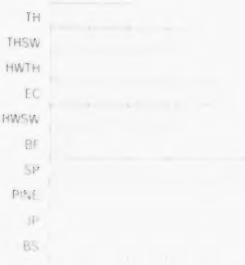
ecosite 5



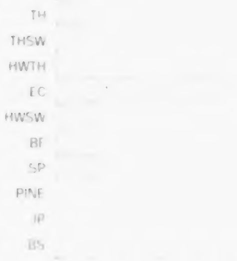
ecosite 5c



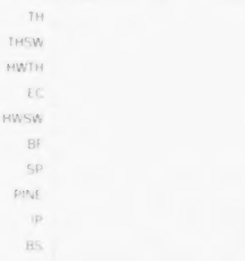
ecosite 6



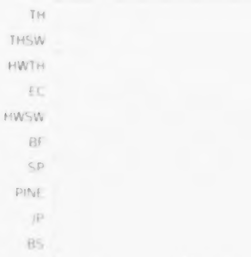
ecosite 6c



ecosite 7



ecosite 7c



Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.

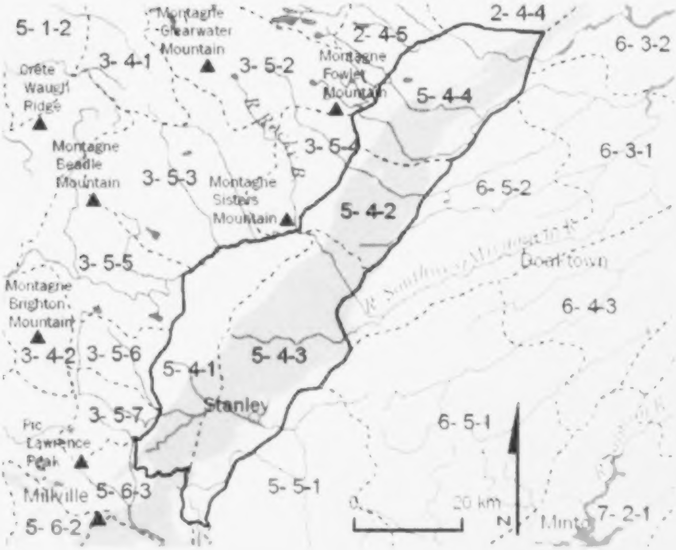
5.4. Buttermilk Ecodistrict

The Buttermilk Ecodistrict lies in central New Brunswick and forms an elongated transitional zone between the elevated Central Uplands Ecoregion and the lower terrain of the Eastern Lowlands Ecoregion.

Geology

The bedrock distinct here is wedged between two distinct geological areas: the large igneous intrusions of the Napadogan Ecodistrict, and the Carboniferous sedimentary lowlands which begin at the Bantalor Ecodistrict and cover the eastern third of the province. Within the Buttermilk Ecodistrict, the strata form elongated alternating bands of diverse bedrock.

The western area is composed of Cambrian to Ordovician metasedimentary rocks consisting of metaquartzite, metagreywacke, and slate of the Tetagouche Group. A small plug of Devonian granitic rock intrudes the terrane just north of Todd Mountain.


5- 1-2
Montagne -Clearwater Mountain
2- 4-4
2- 4-5
6- 3-2
Crête Waugh Ridge
3- 4-1
3- 5-2
Montagne Fowler Mountain
5- 4-4
R. Renous
3- 5-4
6- 3-1
Montagne Beadle Mountain
3- 5-3
Montagne Sisters Mountain
6- 5-2
5- 4-2
3- 5-5
R. Southwest Miramichi R.
Doaktown
Montagne Brighton Mountain
6- 4-3
3- 4-2
3- 5-6
5- 4-1
5- 4-3
Stanley
3- 5-7
6- 5-1
Pic Lawrence Peak
Millville
5- 6-3
5- 5-1
0
20 km
N
Minto
7- 2-1
5- 6-2

Geology of Buttermilk Ecodistrict

Rock Types

Highly calcareous sedimentary

Calcareous sedimentary

Non-calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites

The eastern area is underlain by Silurian greywacke, siltstone, and slate belonging to the Kingsclear Group. These younger strata are more calcareous than are the Tetagouche Group and thus are less resistant to erosion. They are rimmed on the southeast boundary by a narrow band of Carboniferous grey, red, and green sandstone, silt, and conglomerate.

The Catamaran Fault angles southwest across the northern tip of the region. This major regional lineament begins at Miramichi Bay and transects most of central New Brunswick.

Landscape and Climate

The landscape has a decided slope, as elevations decrease from approximately 300 m along the western border to 150 m in the east. This is caused in part by tectonic uplift, and in part by the different lithologies in the east and west sections of the ecodistrict causing different rates of bedrock erosion.

The resistant metasedimentary strata in the west underlie such

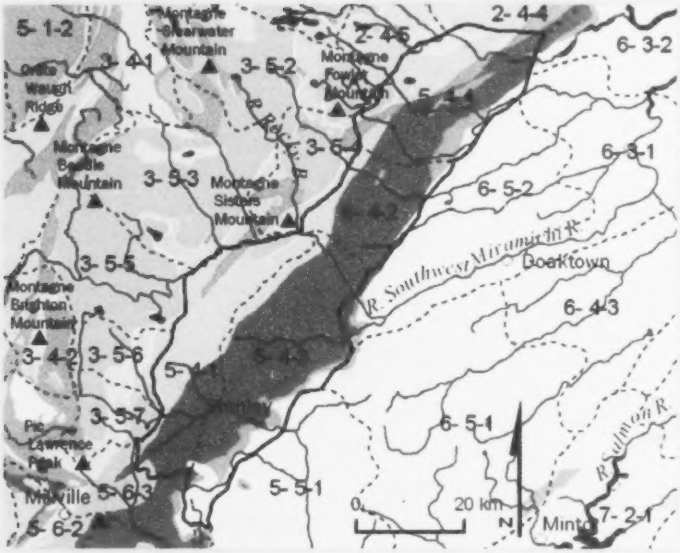
5.4. Buttermilk Ecodistrict

The Buttermilk Ecodistrict lies in central New Brunswick and forms an elongated transitional zone between the elevated Central Uplands Ecoregion and the lower terrain of the Eastern Lowlands Ecoregion.

Geology

The bedrock distinct here is wedged between two distinct geological areas: the large igneous intrusions of the Napadogan Ecodistrict, and the Carboniferous sedimentary lowlands which begin at the Bantalor Ecodistrict and cover the eastern third of the province. Within the Buttermilk Ecodistrict, the strata form elongated alternating bands of diverse bedrock.

The western area is composed of Cambrian to Ordovician metasedimentary rocks consisting of metaquartzite, metagreywacke, and slate of the Tetagouche Group. A small plug of Devonian granitic rock intrudes the terrane just north of Todd Mountain.


5-1-2
Montagne Clearwater Mountain
2-4-4
2-4-5
6-3-2
3-4-1
3-5-2
Montagne Fowler Mountain
Waugh Ridge
3-5-4
Montagne Beadle Mountain
3-5-3
Montagne Sisters Mountain
6-3-1
6-5-2
R. Southwest Miramichi R.
Boiestown
3-5-5
Montagne Brighton Mountain
6-4-3
3-4-2
3-5-6
5-4-3
3-5-7
Pic Lawrence Peak
6-5-1
Millville
5-6-3
5-5-1
5-6-2
0
20 km
N
Minto
7-2-1
R. Salmon R.

Geology of Buttermilk Ecodistrict

Rock Types

- Highly calcareous sedimentary
- ▇ Calcareous sedimentary
- Non-calcareous sedimentary
- ▒ Early Carboniferous sedimentary
- Late Carboniferous sedimentary
- ▒ Mafic volcanic
- Felsic volcanic
- ░ Granites and granodiorites

The eastern area is underlain by Silurian greywacke, siltstone, and slate belonging to the Kingsclear Group. These younger strata are more calcareous than are the Tetagouche Group and thus are less resistant to erosion. They are rimmed on the southeast boundary by a narrow band of Carboniferous grey, red, and green sandstone, silt, and conglomerate.

The Catamaran Fault angles southwest across the northern tip of the region. This major regional lineament begins at Miramichi Bay and transects most of central New Brunswick.

Landscape and Climate

The landscape has a decided slope, as elevations decrease from approximately 300 m along the western border to 150 m in the east. This is caused in part by tectonic uplift, and in part by the different lithologies in the east and west sections of the ecodistrict causing different rates of bedrock erosion.

The resistant metasedimentary strata in the west underlie such features as Turnbull Mountain, Otter Slide Mountain, and Winding Hill. The more easily eroded Silurian bedrock in the east produces a landscape with somewhat gentler relief, especially near Williamsburg Brook and Monaghan Brook.

Rivers are a dominant landscape feature. A few have their origins within the ecodistrict (the Renous and Taxis, for instance) but most arise in the igneous uplands beyond the western border, and flow straight through the Buttermilk Ecodistrict en route to their watershed destination.

Many significant Miramichi feeder rivers make an appearance here: the Little Southwest Miramichi, Renous, Dungarvon, Southwest Miramichi, and Taxis. The only substantial river that drains into the Saint John River watershed is the Nashwaak River, which lies in the extreme south.

The tilted landscape dictates that nearly all the rivers flow from northwest to southeast. Only Catamaran Brook is at variance. It leaves Catamaran Lake to head southwest, but is diverted by the Catamaran Fault to flow northeastward instead. Lakes in the region are few and small, as the land is too sloped and well drained to allow much lacustrine accumulation.

The largest lake in the ecodistrict is McKendrick Lake, which is slightly longer than 1 km.

Topographic relief is defined as much by river action as by differential bedrock erosion. Several of the rivers–especially the Southwest Miramichi, Little Southwest Miramichi, South Branch Renous and Dungarvon–have cut deeply into the sedimentary terrane to create gorges that drop almost 150 m. The combination of incised valleys and bedrock faulting has created a number of interesting landscape phenomena. A steep river canyon called The Jaws lies upstream from Boars Head Narrows on Dungarvon River, and is a popular spot to view salmon. Where Falls Brook meets the Southwest Miramichi, it topples over a plateau in a single, spectacular vertical drop of 35 m in what likely are the highest waterfalls in New Brunswick.

Falls Brook Falls. *Communications New Brunswick photo.*

Buttermilk Falls on Nashwaak River north of Red Rock is much more subdued than Falls Brook, but is another lovely feature of this ecodistrict.

In keeping with its transitional nature, the ecodistrict has a slightly drier, warmer climate than the Central Uplands Ecoregion to the northwest, but is somewhat cooler than most ecodistricts in the adjacent Eastern Lowlands Ecoregion.

Soils

Most soils are fertile, medium-textured, compact basal tills derived from calcareous bedrock and belonging to the Carleton Unit. They are concentrated in the eastern section of the landscape.

The western portion is covered by a variety of soil units derived from metasedimentary, or mixed metasedimentary and igneous, bedrock. The soils here are coarser textured and less fertile, and often contain pebbles of slow-weathering metasedimentary and granitic rocks.

Exposed bedrock and residual soils of the Glassville and Serpentine units dominate the hilltops and upper slopes, whereas deeper, compact soils of the Holmesville and Long Lake units cover the broad ridges and lower slopes.

Biota

The higher hills and calcareous slopes (7,7c) are dominated by tolerant hardwood forests of sugar maple, yellow birch, and beech. These communities tend to occur more frequently over the calcareous Carleton soils.

Stands of sugar maple, yellow birch, and beech are accompanied by red spruce, balsam fir, red maple, and the occasional hemlock on the gentler upper to mid-slopes (5). Scattered white pine and hemlock become more common on lower slopes (4) such as along Miramichi River.

Several fine examples of mixed forest in this area occur near Catamaran Brook. The low, rolling hills possess an impressively diverse collection of sites with hemlock, cedar, red spruce, white pine, balsam fir, yellow birch, and sugar maple. In the understorey may be found Indian cucumber-root, pipsissewa, sweet colt's-foot, pink pyrola, and several orchid species.

The slightly calcareous soils in this ecodistrict have encouraged the rapid growth of shrubs including mountain maple, beaked hazel and hobblebush beneath the mixed forest and tolerant hardwood stands. Shrub competition consequently is somewhat more severe here than in adjacent ecodistricts with less fertile soils.

Cedar is common on calcareous soils and generally is associated with black spruce, red spruce, and balsam fir in poorly drained areas (3, 6). It also can occur on upper slopes (7, 7c).

A notable cedar wetland is situated just west of Sutherland Siding. The swamp contains cedar, poplar, and balsam fir with white adder's-tongue and some uncommon round-leaved hepatica.

The rare closed gentian grows in the Bartholomew Lake area, close to where naturalists have observed a number of butterfly species, including the rare early hairstreak, hoary elfin, and hoary comma. Their larvae feed on beech nuts, mayflower, and skunk currant, respectively.

Several rivers and streams provide spawning grounds for sea-run brook trout, and for the famous Miramichi salmon. The riverbanks also support an annual migration of sports fishermen and anglers.

Settlement and Land Use

Buttermilk Ecodistrict lies within traditional Maliseet territory. The area was used by early aboriginals for hunting and fishing, and for overland excursions between the Saint John and Miramichi rivers. A major canoe route passed through this ecodistrict up the Naskwaak River to Cross Creek and across a portage to the Taxis River, which led to the Southwest Miramichi. The Taxis River was named after a Mi'kmaq called Pier Tax or Taxous who lived in the area.

European settlement in the area received a boost in the 1830s with the construction of the Royal Road from Nashwaak to Stanley. Immigrants were enticed by advertisements of the New Brunswick and Nova Scotia Land Company, headed by Edward Stanley (hence the village of Stanley). Hayesville was named after its first postmaster, Peter Hayes, who arrived from Ireland in 1821.

Most of the villages were located beside rivers: Hayesville and Tugtown along the Southwest Miramichi River, for instance, and Stanley and Giant's Glen on the Naskwaak River. The last-named village received its title allegedly because some of its original Irish inhabitants were notoriously short. The village of Limekiln had several nearby lime kilns that local residents used to burn the local calcareous bedrock into lime fertilizer.

The 1912 completion of the National Transcontinental Railway (NTR) from Moncton to Québec encouraged the development of a few new communities along the line. McGivney became a major railway depot at the junction of the NTR and the Canada Eastern Railway between Fredericton and Chatham. Yet despite the Royal Road and the railway, most of this area remained unpopulated. Even today, it is virtually uninhabited north of the Southwest Miramichi River.

The ecodistrict's forests were exploited long before the first permanent European settlers arrived. The larger rivers such as the Southwest Miramichi and Renous allowed easy access to timber and provided a route to sawmills upriver in Boiestown and Doaktown. As with many other regions of the province, the largest trees were felled before 1820, five years before the 1825 Miramichi Fires.

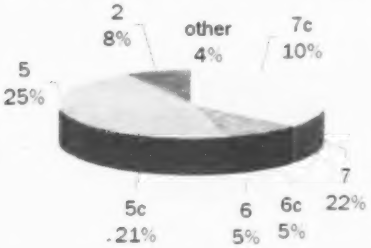
Agricultural activities are concentrated over the lime-rich soils in the vicinity of Williamsburg, Cross Creek, Maple Grove, and Parker Ridge.

5.4 Buttermilk Ecodistrict at a Glance

Ecoregion: Valley Lowlands
Area: 215, 338 ha
Average elevation above sea level: 245 m
Average May–September precipitation: 450–500 mm
Average annual degree-days above 5 °C: 1650–1750

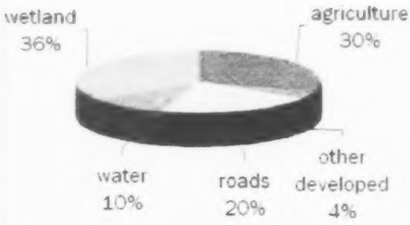
95% of Buttermilk Ecodistrict has forest cover

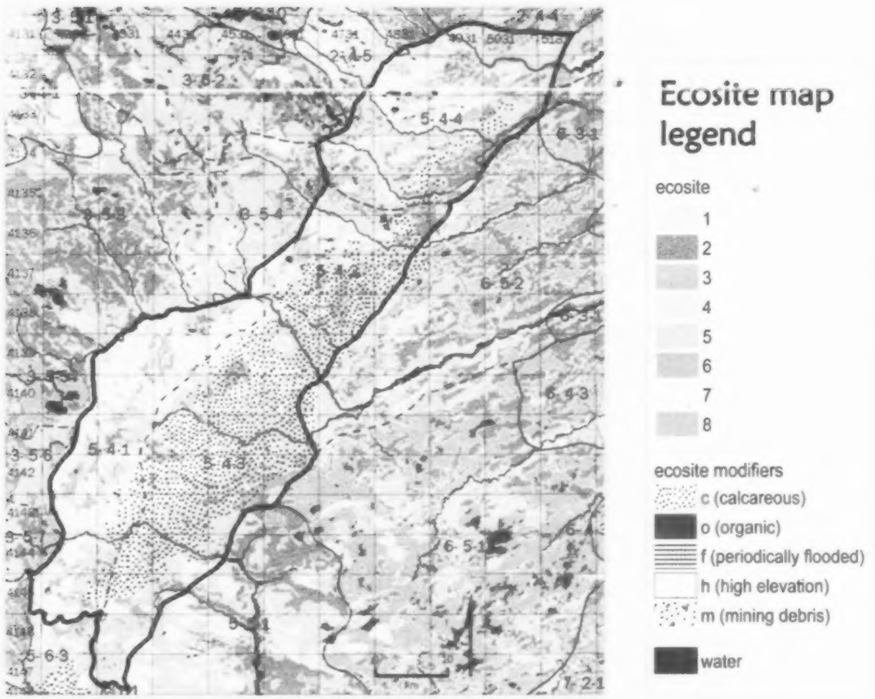
ecosite coverage of forest area



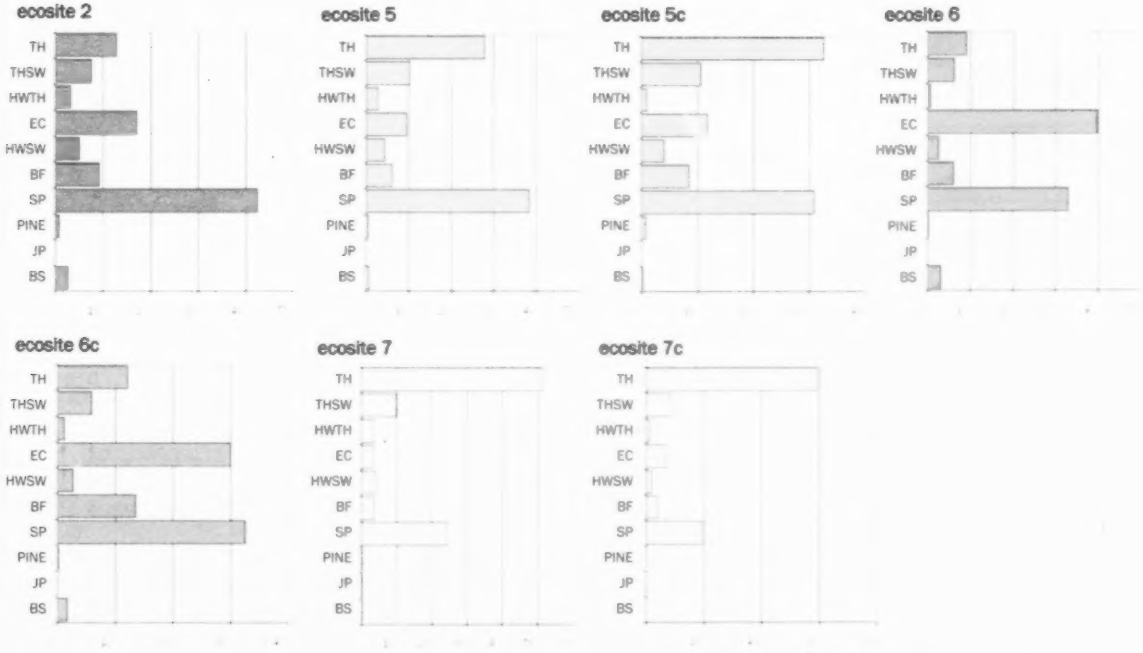
5% of Buttermilk Ecodistrict is not forested

uses of non-forest area




Ecosite map legend
ecosite
1
▨ 2
3
4
5
6
7
8
ecosite modifiers
c (calcareous)
o (organic)
f (periodically flooded)
h (high elevation)
m (mining debris)
water
3-5-2
5-4-4
6-3-1
3-5-3
6-5-4
5-4-2
6-5-2
6-4-3
5-4-1
5-4-3
3-5-6
6-5-1
5-6-3
7-2-1
2-4-5

Percent cover of forest stand types by ecosite



Vertical axis: TH—tolerant hardwood species; THSW—tolerant hardwood with softwood species; HWTH—intolerant hardwood and tolerant hardwood species; EC—eastern white cedar; HWSW—intolerant hardwood and softwood species; BF—balsam fir; SP–red or white spruce; PINE—white pine; JP jack pine; BS—black spruce **Horizontal axis**: percent cover.

5.5. Cardigan Ecodistrict

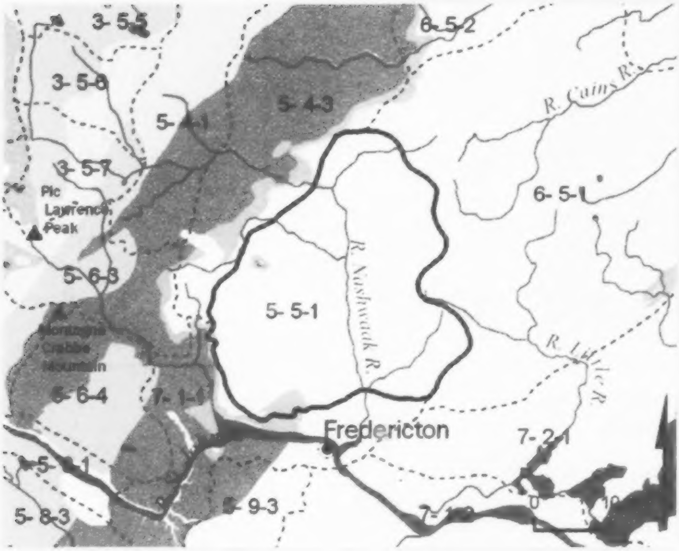
The Cardigan Ecodistrict is a gently rolling area in central New Brunswick. It straddles, and is bisected by, the lower reaches of the Nashwaak River.

Geology

The bedrock is composed almost entirely of Carboniferous sedimentary rocks. Most of these lithologies consist of grey to olive sandstone and conglomerate with minor siltstone and shale. Strata of red sandstone, conglomerate, and siltstone also are situated in patches near Cross Creek and McLeod Hill.

McLeod Hill is one of two sites in the ecodistrict featuring igneous bedrock. Basalt, mafic volcanic rock, underlies the McLeod Hill escarpment, and also occurs at the village of Manzer on the Nashwaak River.

The sedimentary rocks in the northern part of the ecodistrict are highly fossiliferous. Rock outcrops holding large fossils of Pennsylvanian tree trunks occur along the road northwest of Nashwaak Bridge near Cross Creek Station. Cross Creek Station also contains Pennsylvanian plant fossils and pyrite nodules in a sandstone outcrop associated with a coal seam.



Geology of Cardigan Ecodistrict

Rock Types

- Highly calcareous sedimentary
- ▨ Calcareous sedimentary
- Non-calcareous sedimentary
- Early Carboniferous sedimentary
- Late Carboniferous sedimentary
- Mafic volcanic
- Felsic volcanic
- Granites and granodiorites

Landscape and Climate

The Nashwaak River valley bisects the ecodistrict into two plateaus that sit at about 150 m above sea level. The landscape lacks dramatic peaks or valleys, and relief rarely exceeds 60 m. Topographic variety is achieved only where the Nashwaak River and its tributaries have incised the soft, sedimentary bedrock into moderate hills and valleys with good drainage. The Nashwaak River valley forms a corridor for two highways and a railway line running parallel to, and within a few hundred metres of, the river. Almost all streams and rivers here lead to the Nashwaak River in a dendritic pattern resembling veins on a leaf. The main exception is Nashwaaksis Stream, which drains directly into the Saint John River.

The landscape features few lakes, due to the irregular, well draining terrain. One of the few is Killarney Lake, which in summer provides a cool swimming retreat for the residents of nearby Fredericton.

The climate is relatively warm and dry, but does not attain the warmer average temperatures of the Grand Lake Ecoregion to the south.

Soils

Virtually all soil units are derived from Carboniferous grey sandstone and red mudstone. They range from compact tills to glaciofluvial deposits and have a variety of textures. Where the soils are coarse textured and acidic, they possess limited fertility, although microsites with more favourable growing conditions occur in zones with well drained seepage slopes.

Soils of the Reece Unit are the most widespread and consist of compact, medium-textured basal tills. Two large ablation deposits of the Sunbury Unit are found north of Killarney Lake and around Dunbar Stream. These droughty soils are deep, coarse textured, and cobbly, with low water retention.

A large glaciofluvial deposit belonging to the Riverbank Unit overlies Penniac Brook, whereas more recent alluvial deposits cover the Nashwaak and Tay river valleys. Both deposits are coarse textured and very gravelly with low fertility. The alluvial deposits, tend to be capped with the more fertile, fine-grained silts and sands of the Interval Unit. Peat soils of the Organic Unit are scattered along the headwaters of Nashwaaksis Stream and Penniac Brook. As well, the lower reaches of Nashwaaksis Stream feature a small area of Mafic Volcanic Unit soil derived from the Royal Road basalt.

Biota

The predominant forest cover occurs on moist, mid-slope terrain (5) and is composed of red spruce, balsam fir, and red maple with scattered hemlock and white pine.

Occasional stands of sugar maple, yellow birch, and beech occur in the west where soils are deep and loamy on ridgetops and upper slopes (8). Black spruce and cedar are more prevalent in the east adjoining Bantalor Ecodistrict, where peaty soils are more common (3, 6).

Jack pine and black spruce are plentiful throughout the Eastern, Grand Lake and Valley lowlands but are scarce in this ecodistrict. Historically, fires here have been smaller and less frequent than in adjoining ecodistricts. This may be due in part to the relief created by the wide, deeply incised river valleys, and to the natural fire break formed by the Nashwaak River. The hardwood-dominated landscape to the west also may have provided some protection from fire, as flames move more readily through coniferous forests.

Extensive communities of red maple, trembling aspen, large-toothed aspen, balsam fir, white birch, and grey birch occur on areas disturbed by logging activities. The formerly abundant forests of mature white pine all but vanished in the early 1800s due to heavy cutting. Today, however, many pure stands of young white pine appear to be thriving along the lower valley slopes (2) and bottomlands (7b) of the Nashwaak River.

Settlement and Land Use

The Cardigan Ecodistrict lies within traditional Maliseet territory. The area was used by early aboriginals for hunting and fishing, and for overland excursions into Miramichi country. A major canoe route passed from the Saint John River up the Naskwaak River to Cross Creek and across a portage to the Taxis River, which led into the Southwest Miramichi River. The village of South Portage on Highway 8 marks the site of one former portage, and Cross Creek reportedly was named in reference its position at the crossroads between the Naskwaak and Miramichi river systems.

The earliest non-aboriginal inhabitants of the lower Nashwaak River were French grant-holders in the 1600s, who set up forts at the mouth of the Nashwaak River in the Aukpaque Ecodistrict. The upper Nashwaak, however, remained essentially unsettled until construction of the Royal Road in 1832. The road encouraged settlement by English, Scottish, and Irish immigrants who established such villages as Durham Bridge, Taymouth, and Penniac.

The early 1800s also saw settlement in communities beyond the Nashwaak River valley at places such as Woodlands, Birdton, and Cardigan. The last two villages represent some of the very few Welsh communities in New Brunswick, and the local churches still preserve graveyards with Welsh surnames engraved on worn marble tombstones.

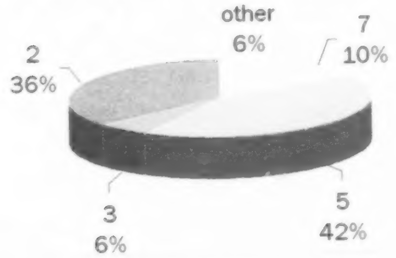
Coal deposits occur across the area but have not been commercially developed. Outcrops of rough sandstone along Highway 8 are occasionally quarried for rubble stone. The Royal Road basalt quarry at McLeod Hill produces construction material and road aggregate for the greater Fredericton area.

5.5 Cardigan Ecodistrict at a Glance

Ecoregion: Valley Lowlands
Area: 86, 707 ha
Average elevation above sea level: 150 m
Average May–September precipitation: 400–450 mm
Average annual degree-days above 5 °C: 1550–1700

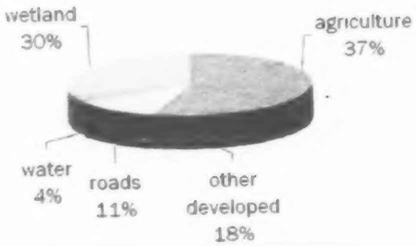
91% of Cardigan Ecodistrict has forest cover

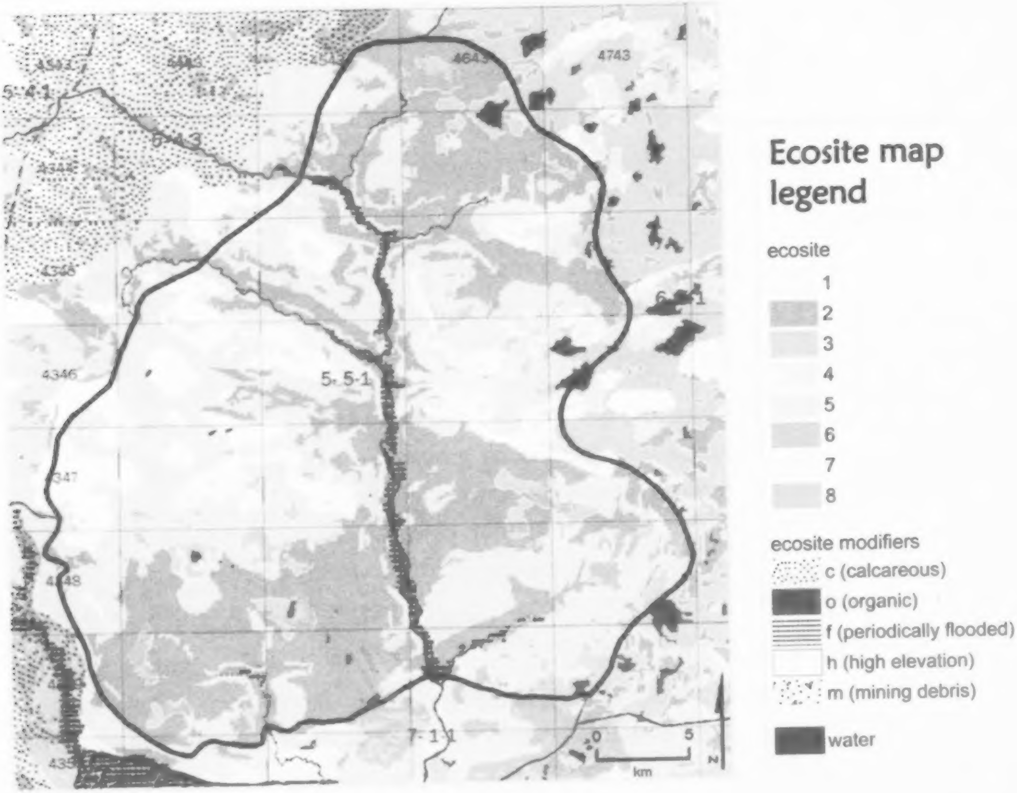
ecosite coverage of forest area



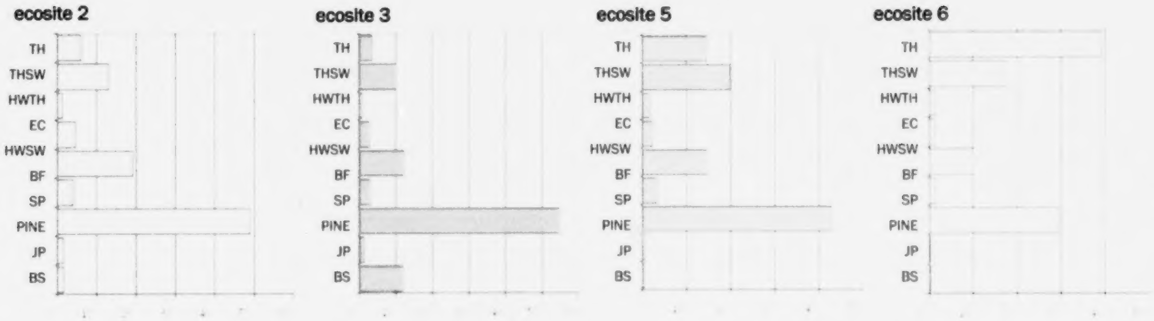
9% of Cardigan Ecodistrict is not forested

uses of non-forest area




4543
4643
4743
5.4.1
5.4.3
4344
4345
4346
4347
4348
5.5-1
6.6-1
7-1.1
0
5
km
N
Ecosite map legend
ecosite
1
2
3
4
5
6
7
8
ecosite modifiers
c (calcareous)
o (organic)
f (periodically flooded)
h (high elevation)
m (mining debris)
water

Percent cover of forest stand types by ecosite



Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.

5.6. Nackawic Ecodistrict

The Nackawic Ecodistrict is an undulating area in west-central New Brunswick that parallels the Saint John River but lies just east of the river valley.

Geology

The western third of the Nackawic Ecodistrict is underlain primarily by Cambrian to Ordovician sedimentary rocks of the Tetagouche Group, which contain greywacke, siltstone, and sandstone. The northwest corner contains Carboniferous sedimentary rocks composed of red and grey sandstone, siltstone, and conglomerate. Between the two sedimentary areas are alternating bands of Devonian felsic and mafic rocks.

The remainder of the ecodistrict consists of two large intrusions of granite and granodiorite that bracket an extensive area of Silurian quartzose and calcareous greywacke and slate. The granitic rocks are centred around Nackawic and Springfield.

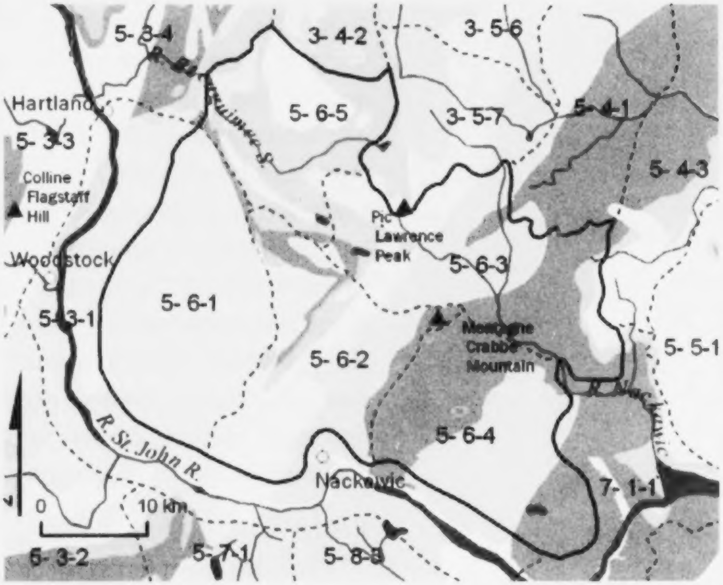
A small zone of Silurian calcareous sedimentary rocks occurs in the extreme southeast corner in the vicinity of Scotch Lake. The only true carbonate deposit is represented by a small pocket of Ordovician limestone at South Waterville.

Landscape and Climate

The landscape forms a series of broad ridges separated by more rolling lowlands. Most ridges and mountains are underlain by volcanic or granitic terrain, such as Big and Little Spruce peaks and Maple Ridge. In some locations such as Dorn Ridge, a prominence has been created through the differential erosion of siliceous (that is, more resistant) and non-siliceous (less resistant) sedimentary rocks. The lowlands tend to be concentrated over the western area of Cambrian to Ordovician sedimentary rocks, and contain more wetland areas than does the rest of the ecodistrict. Another lowland area occurs around Scotch Lake over the calcareous sedimentary rocks.

Elevations tend to increase from south to north. They begin at about 120 m where the region hugs the Saint John River valley, then gradually rise to 400 m in the highlands near Cloverdale, where the landscape merges with the rugged terrain of Bantalor and Serpentine ecodistricts in the Central Uplands Ecodistrict.

Rivers dominate this ecodistrict. The tributaries and branches of Nackawic Stream cover much of the area, converge at a point near Pinder, and then flow downhill to meet the Saint John River at Nackawic just outside the ecodistrict. The Keswick River and its associated streams flow through the northeast corner of the region and are mirrored in the northwest corner by Becaguimac Stream and its feeders. The rivers here generally meander around topographic highs instead of incising the landforms.



Geology of Nackawic Ecodistrict

Rock Types

Highly calcareous sedimentary

▨ Calcareous sedimentary

Non-calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites

Lakes are generally modest in size and depth. The most outstanding is Ayers Lake in the northwest. It is 21 m deep and is one of only a dozen lakes in the province with a self-sustaining population of lake trout. The undisturbed nature this pristine lake makes it one of the most beautiful wilderness spots in the province.

The climate here is relatively moist and warm. The area receives slightly more precipitation than do adjacent ecodistricts to the east and west. Temperatures are somewhat cooler than in

Grand Lake Lowlands Ecodistrict to the east, but become warmer farther west towards the lowlands of Saint John River valley.

Soils

Areas underlain by metasedimentary rocks occur in the western third of the ecodistrict, and are associated with moderately fertile compact tills of the Holmesville Unit. Calcareous sedimentary rocks in the east have given rise to compact and non-compact tills of the Carleton and Thibault units. These latter units overlie the terrain near Scotch Lake and Hainesville, and represent the most fertile soils in the area, especially where they are well drained.

Soils derived from granitic bedrock, or from a mixture of granitic and metasedimentary rocks, are represented here by several units including the Juniper, Tuadook, Irving, and Catamaran. These sandy, stony soils are concentrated over granitic bedrock areas along the Nackawic Stream and around Springfield.

Glaciofluvial deposits are represented by the Gagetown and Grand Falls units, which span the lower Nackawic Stream and the South Branch Becaguimec Stream respectively.

Elsewhere, small areas of Organic Unit soils coincide with bogs and fens. These poorly drained soils occur mainly in the western region, with one isolated patch over a bog just north of Upper Queensbury.

Biota

The dominant forest is composed of red spruce, balsam fir, and red maple with significant hemlock. Pure hemlock stands are restricted to less disturbed areas with a slightly cooler topoclimate.

The well drained ridgetops (8) support tolerant hardwoods such as sugar maple, yellow birch, beech, and white ash. The moist, strongly acidic granitic slopes (5) display a high proportion of coniferous trees, whereas the moist sedimentary upper slopes (7) have fewer conifers and more hardwoods.

Areas underlain by acidic, sandy, or stony soils are dry and low in nutrients; the associated cover is most often black spruce and pines. White pine once was plentiful across the ecodistrict, but now is abundant only on coarse-textured valley bottoms (2). At the other ecosite extreme, cedar is prevalent in softwood stands on moist seepage slopes (6) and calcareous soils rocks (6c, 7c). Cedar-softwood forests also occur over Organic soil areas.

Early successional stands contain trembling aspen and large-toothed aspen with white birch, grey birch, and red maple.

Several interesting or rare plants occur at Carrs Siding east of Maplewood including two species of grape fern and the adder's tongue fern.

The shallow waters of Scotch Lake are habitat for Robbin's spikerush, one of only a handful of know locations for this plant species.

Settlement and Land Use

The Nackawic Ecodistrict lies within traditional Maliseet territory. The area lies directly opposite a major early native village at Meductic, and was used by aboriginals for hunting and fishing. *Nackawic* was derived from the Maliseet *nelgwaweegek* meaning *straight stream*. The name referred to the fact that Nackawic Stream's lower reaches originally paralleled the Saint John River. Construction of the Mactaquac dam has since realigned and altered waterways all along the middle Saint John River valley.

Europeans did not arrive here until the early 1800s, and settlement did not begin in earnest until after 1840. Over time, immigrants established villages whose names immortalize the original grant recipients. Ebenezer Briggs lived in Briggs Corner, Peleg Staples in Staple Settlement and William Caverhill in Lower Caverhill. A group of Scottish immigrants from Roxburgh and Dumfries opted for collective rather than individual nomenclature calling their community Scotch Lake.

Today, forestry on both private and Crown land is a major regional employer. Agricultural areas presently cover 8% of the ecodistrict and are dominated by pasture and grain crops, which are cultivated to support beef and dairy production.

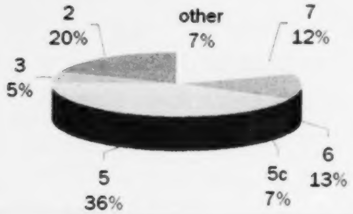
A variety of economic mineral deposits have been discovered here including molybdenum, zinc, coal, bog manganese and beryl. Limestone formerly was quarried from the Waterville area, but, with the exception of sand and gravel, the ecodistrict's mineral resources have remained undeveloped.

5.6 Nackawic Ecodistrict at a Glance

Ecoregion: Valley Lowlands
Area: 143, 646 ha
Average elevation above sea level: 185 m
Average May-September precipitation: 425–450 mm
Average annual degree-days above 5 °C: 1650–1700

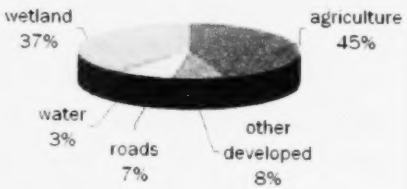
91% of Nackawic Ecodistrict has forest cover

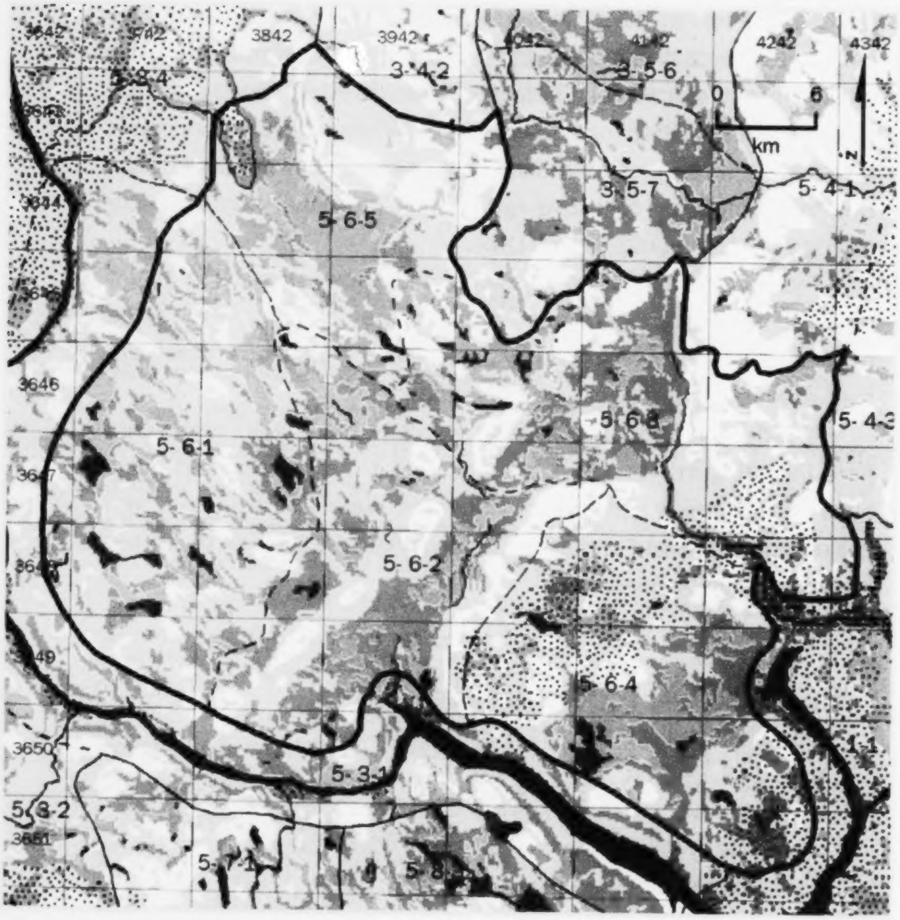
ecosite coverage of forest area



9% of Nackawic Ecodistrict is not forested

uses of non-forest area




3642
3742
3842
3942
4042
4142
4242
4342
3-4-2
3-5-6
3-8-4
0
6
km
N
3-5-7
5-4-1
5-6-5
3644
3646
5-6-8
5-4-3
5-6-1
3647
5-6-2
3648
3649
5-6-4
3650
5-3-1
1-1
5-3-2
3651
5-7-1
5-8-1

Ecosite map legend

ecosite

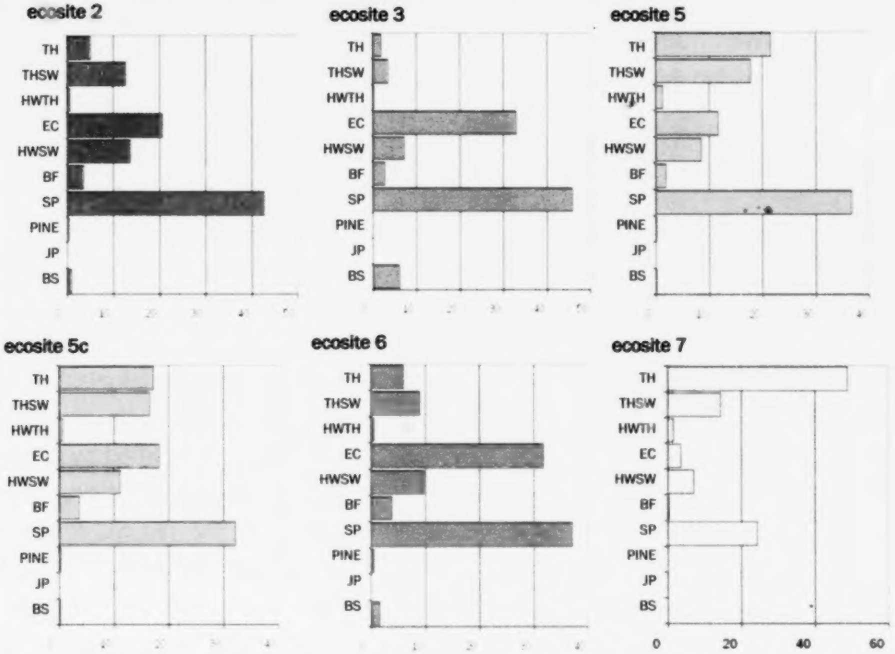
- 1
- ▨ 2
- ▨ 3
- 4
- 5
- ▨ 6
- 7
- ▨ 8

ecosite modifiers

- c (calcareous)
- ■ o (organic)
- ☰ f (periodically flooded)
- h (high elevation)
- m (mining debris)

■ water

Percent cover of forest stand types by ecosite



Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.

5.7. Cranberry Ecodistrict

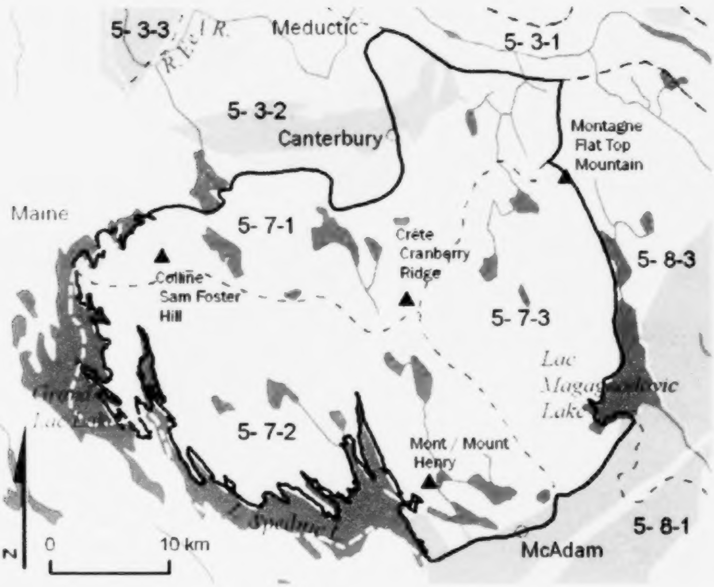
The Cranberry Ecodistrict is a small, lake-bound plateau area in southwest New Brunswick wedged between the Maine border and the Grand Lake Lowlands.

Geology

The bedrock consists primarily of pink granitic rock with areas of muscovite-bearing granite and felsic porphyry. Granodiorite occurs in two small zones, one underlying Cranberry Ridge south of Canterbury, and the other on the western border where it has given rise to Green Mountain and Pemberton Ridge.

A strip of Cambrian to Devonian sedimentary rocks skims the northwest boundary. These rocks are composed of feldspathic sandstone, siltstone, shale with quartzite and minor carbonates. A small patch of resistant Devonian mafic volcanic rocks is also present here and has created the topographic feature called Dorrington Hill.

Landscape and Climate



Geology of Cranberry Ecodistrict

Rock Types

- Highly calcareous sedimentary
- Calcareous sedimentary
- Non-calcareous sedimentary
- Early Carboniferous sedimentary
- Late Carboniferous sedimentary
- Mafic volcanic
- Felsic volcanic
- Granites and granodiorites

The landscape here is among the most scenic in the province, with numerous granite-bound lakes and dramatic topography. It is a region of steep-sided hills that rise 100 m above the surrounding ecodistricts, and ridges that crest over 220 m. Cranberry Ridge provides the highest elevation in the ecodistrict at 406 m.

The many local lakes and their associated rivers show a pronounced northwest-southeast alignment that originated with the regional bedrock structure and later was amplified by glacial effects. The lineation was followed by the old St. Andrews and Québec Railway line built from St. Andrews through Canterbury to Richmond Corner in the mid 1800s.

The ecodistrict's borders are defined by its lakes: Magaguadavic and Little Magaguadavic lakes in the east, and Grand and Spednic lakes in the west. The middle of the ecodistrict is marked by a sequence of lakes—Second Eel, Third Eel and LaCoote—that join Palfrey and Spednic lakes. Together, these waterways form a lovely trail which, with a few portages, enables the energetic paddler to move from the Eel River in the north down to the St. Croix River and eventually Passamaquoddy Bay.

As a consequence of its relatively high elevations, the ecodistrict intercepts more moisture than adjoining ecodistricts to the north and east. The summer temperatures here are exceeded only by ecodistricts of the Grand Lake Lowlands Ecoregion.

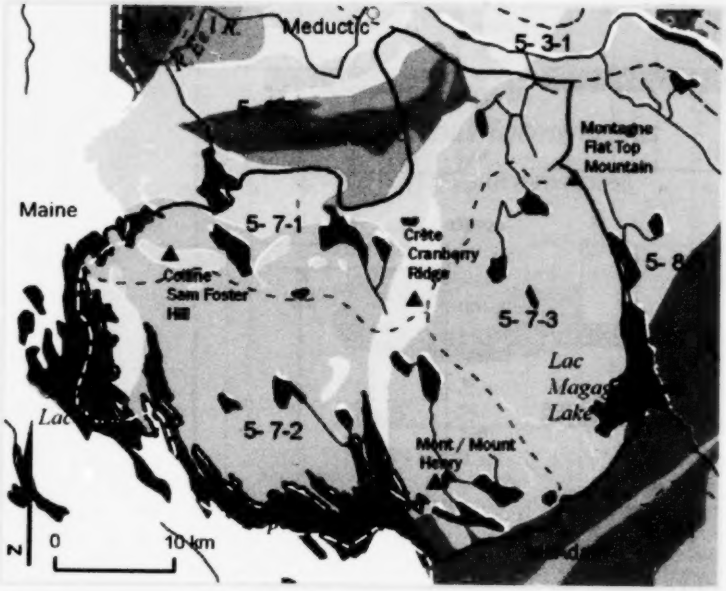
Soils

The granite bedrock in the western area is overlain primarily by soils derived from a mixture of glacially transports metasedimentary rocks and local granitic rocks. Many of these compact, loamy basal tills belong to the Long Lake Unit and are more fertile than soils obtained from purely granitic bedrock.

Soils derived from granitic terrain are more common in the

Landscape and Climate

The landscape here is among the most scenic in the province, with numerous granite-bound lakes and dramatic topography. It is a region of steep-sided hills that rise 100 m above the surrounding ecodistricts, and ridges that crest over 220 m. Cranberry Ridge provides the highest elevation in the ecodistrict at 406 m.



Geology of Cranberry Ecodistrict
Rock Types

- Highly calcareous sedimentary
- ■ Calcareous sedimentary
- Non-calcareous sedimentary
- ▨ Early Carboniferous sedimentary
- Late Carboniferous sedimentary
- ▨ Mafic volcanic
- Felsic volcanic
- ▨ Granites and granodiorites

The many local lakes and their associated rivers show a pronounced northwest-southeast alignment that originated with the regional bedrock structure and later was amplified by glacial effects. The lineation was followed by the old St. Andrews and Québec Railway line built from St. Andrews through Canterbury to Richmond Corner in the mid 1800s.

The ecodistrict's borders are defined by its lakes: Magaguadavic and Little Magaguadavic lakes in the east, and Grand and Spednic lakes in the west. The middle of the ecodistrict is marked by a sequence of lakes—Second Eel, Third Eel and LaCoote—that join Palfrey and Spednic lakes. Together, these waterways form a lovely trail which, with a few portages, enables the energetic paddler to move from the Eel River in the north down to the St. Croix River and eventually Passamaquoddy Bay.

As a consequence of its relatively high elevations, the ecodistrict intercepts more moisture than adjoining ecodistricts to the north and east. The summer temperatures here are exceeded only by ecodistricts of the Grand Lake Lowlands Ecoregion.

Soils

The granite bedrock in the western area is overlain primarily by soils derived from a mixture of glacially transports metasedimentary rocks and local granitic rocks. Many of these compact, loamy basal tills belong to the Long Lake Unit and are more fertile than soils obtained from purely granitic bedrock.

Soils derived from granitic terrain are more common in the eastern region, and are represented by an extensive area of non-compact ablation tills belonging to the Juniper Unit. These soils are deep and extremely coarse textured.

The ridges northwest of Magaguadavic Lake are covered by compact basal tills of the Tuadook Unit. Although they also are derived from granite, these soils have a fine loamy texture and are somewhat more productive than Juniper soils.

Biota

The dominant forest cover is a tolerant hardwood community composed of beech, sugar maple, yellow birch, and red maple with occasional red oak and white ash on the ridges (8). On well drained mid-slopes, the forest tends to be a mixture of red spruce and balsam fir with hemlock (5). Notable hemlock stands can be found along the shores of Spednic and Palfrey lakes.

Cedar is prevalent on a variety of ecosites (3, 6, 7, 7c), where it can occur with red spruce, black ash, and red maple. Black spruce and tamarack tend to be concentrated more in the acidic bogs such as occur in the southeast corner near Foster Lake (3b).

Widespread patch-cutting and selected harvesting resulted in abundant intolerant hardwood stands consisting of trembling aspen, large-toothed aspen white birch, grey birch, and red maple.

A beautiful and remote forest stand occurs on East Grand Lake, and consists of mature sugar maple, yellow birch, and hemlock. The lake supports lake trout, land-locked salmon, and brook trout, whose populations have been boosted by stocking programs. Bald eagles nest in trees along its cobblestone shoreline, as well as at Spednic Lake a few kilometres farther south.

Most of the rare or vulnerable plants in this area are associated with its streams or lakes. Diggity Stream on the east shore of Spednic Lake supports a population of silky dogwood and the rare low water-milfoil. The shallower waters at North Lake contain New Brunswick's first recorded population of floating bladderwort.

Shogomoc Stream lies in the eastern part of the ecodistrict, flowing between steep granitic hills east of Dow Settlement. The rare riverweed nestles just below the waterline along the stream.

Settlement and Land Use

The Cranberry Ecodistrict straddles the traditional territory of the Maliseet and Passamaquoddy who hunted and fished throughout the area. Native encampments dated at 6000 to 7000 years old occur along the chain of lakes and rivers comprising the Spednic Lake-St. Croix River system. One of the early aboriginal villages was situated on the southern boundary at St. Croix, and was named Kilmaquac.

The earliest known European inhabitants were Loyalist descendants who arrived in the early 1800s, settling close to the Saint John River valley. The communities' names reflect their original dwellers such as Allandale after Adam Allan, and Dow Settlement after David Dow. A few communities such as Cottrell and Shogomoc also arose beside the railroad from St. Andrews through Canterbury after 1858, but these short-lived villages have long since been abandoned.

The largest town is McAdam, which sits on the border between Cranberry and Magaguadavic ecodistricts. The McAdam railway station lay at the junction of railroads heading north to Edmundston, west to Montreal, and south to St. Andrews or St. Stephen, and formerly serviced sixteen trains a day. This heritage building was constructed in 1911 of granite quarried from local glacial boulders, and was declared a National Historic Site in 1976.

Residents who did not work for the railway were employed almost solely in the timber business, cutting trees, and running sawmills. Today, logging, outfitting, and tourism are mainstays of the local economy.

McAdam Railway Station is a National Historic Site. Photograph courtesy of the Village of McAdam.

Camping and canoeing are popular pastimes in the Cranberry Ecodistrict. This site at Diggity Stream has been in use as a campsite for more than 2000 years.

5.7. Cranberry Ecodistrict at a Glance

Ecoregion: Valley Lowlands

Area: 121, 333 ha

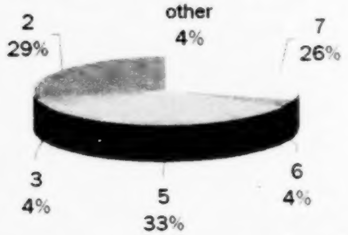
Average elevation above sea level: 166 m

Average May-September precipitation: 450–475 mm

Average annual degree-days above 5°C: 1600–1700

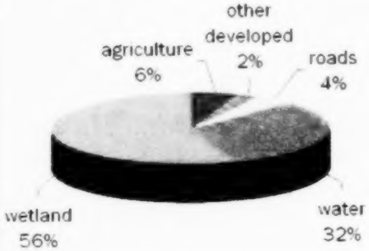
86% of Cranberry Ecodistrict has forest cover

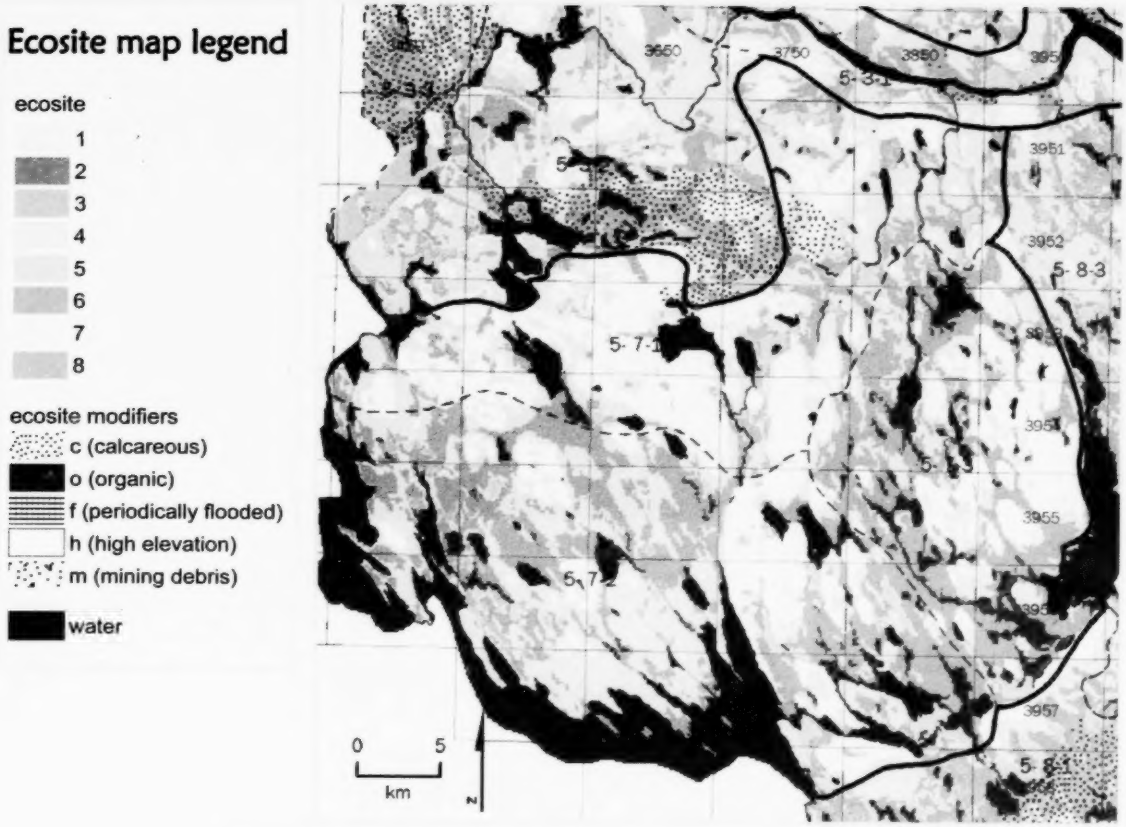
ecosite coverage of forest area



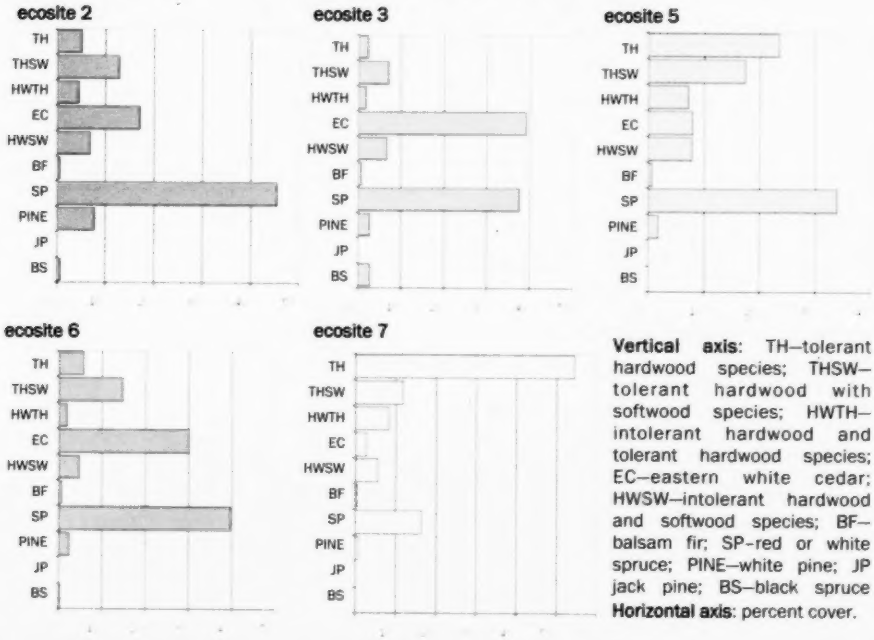
14% of Cranberry Ecodistrict is not forested

uses of non-forest area




Ecosite map legend
ecosite
1
2
3
4
5
6
7
8
ecosite modifiers
c (calcareous)
o (organic)
f (periodically flooded)
h (high elevation)
m (mining debris)
water
3650
3750
3850
5-3-1
3951
3952
5-8-3
5-7-1
5-7-2
3955
3957
5-8-1
0
5
km
N

Percent cover of forest stand types by ecosite



Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.

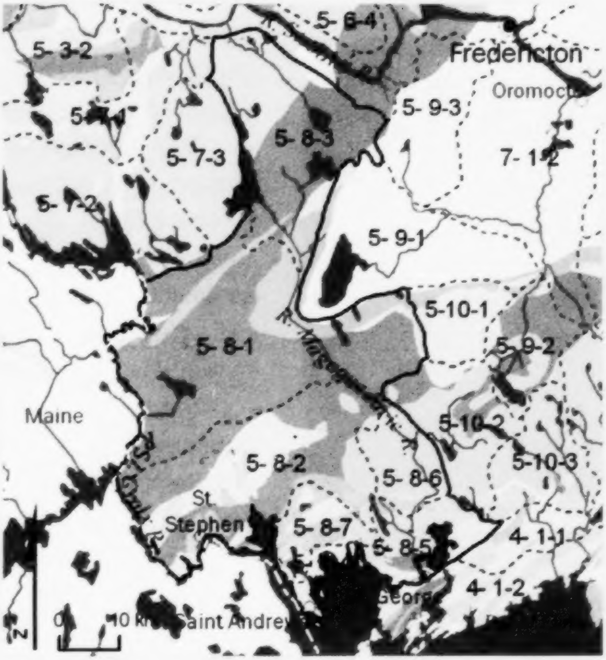
5.8. Magaguadavic Ecodistrict

Magaguadavic Ecodistrict is an undulating plateau, intermediate between higher elevations of the Cranberry Ecodistrict to the northwest, and the low-lying Fundy Coastal Ecodistrict to the south.

Geology

The bedrock consists primarily of two basic rock types: Ordovician to Devonian sedimentary strata and Silurian to Devonian granitic rocks.

The central core of the ecodistrict comprises Silurian calcareous sandstone, slate, and siltstone adjoining a narrower belt of siliceous Ordovician shale, greywacke, and siltstone. Another small zone of Silurian-Devonian sedimentary rock stretches along the coast of Passamaquoddy Bay. The St. Andrews peninsula also is composed of Silurian to Devonian red and grey sandstone, shale, and conglomerate, with bands of Devonian mafic volcanic rocks. These rocks include basalt that contains white vesicles, the remains of volcanic gas bubbles that subsequently became filled with calcite.



Geology of Magaguadavic Ecodistrict

Rock Types

Highly calcareous sedimentary

▨ Calcareous sedimentary

Non-calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites

Elsewhere, the predominant bedrock is composed of Silurian to Devonian of granite and granodiorite. The most extensive area occurs in the southeast, and encompasses Lake Utopia and Digdeguash Lake. The St. Stephen area contains a mixed assemblage of granitic and gabbroic rocks, and another area of granite appears northeast of Magaguadavic Lake.

In addition to these more dominant lithologies, a small patch of Devonian felsic volcanic rocks borders the shores of Harvey Lake. Just south of Chamcook, is a narrow band of Jurassic diabase that transects the St. Andrews Peninsula; it represents the youngest bedrock unit in the area.

Some volcanic outcrops along Harvey Lake display a hexagonal pattern of columnar jointing that developed hundreds of million years ago as the rocks cooled.

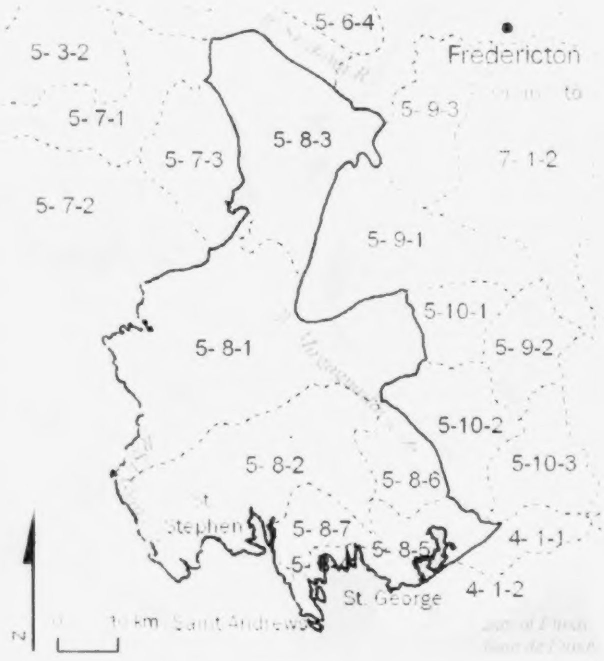
5.8. Magaguadavic Ecodistrict

Magaguadavic Ecodistrict is an undulating plateau, intermediate between higher elevations of the Cranberry Ecodistrict to the northwest, and the low-lying Fundy Coastal Ecodistrict to the south.

Geology

The bedrock consists primarily of two basic rock types: Ordovician to Devonian sedimentary strata and Silurian to Devonian granitic rocks.

The central core of the ecodistrict comprises Silurian calcareous sandstone, slate, and siltstone adjoining a narrower belt of siliceous Ordovician shale, greywacke, and siltstone. Another small zone of Silurian-Devonian sedimentary rock stretches along the coast of Passamaquoddy Bay. The St. Andrews peninsula also is composed of Silurian to Devonian red and grey sandstone, shale, and conglomerate, with bands of Devonian mafic volcanic rocks. These rocks include basalt that contains white vesicles, the remains of volcanic gas bubbles that subsequently became filled with calcite.



Geology of Magaguadavic Ecodistrict

Rock Types

Highly calcareous sedimentary

Calcareous sedimentary

Non calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites

Elsewhere, the predominant bedrock is composed of Silurian to Devonian of granite and granodiorite. The most extensive area occurs in the southeast, and encompasses Lake Utopia and Digdeguash Lake. The St. Stephen area contains a mixed assemblage of granitic and gabbroic rocks, and another area of granite appears northeast of Magaguadavic Lake.

In addition to these more dominant lithologies, a small patch of Devonian felsic volcanic rocks borders the shores of Harvey Lake. Just south of Chamcook, is a narrow band of Jurassic diabase that transects the St. Andrews Peninsula; it represents the youngest bedrock unit in the area.

Some volcanic outcrops along Harvey Lake display a hexagonal pattern of columnar jointing that developed hundreds of million years ago as the rocks cooled.

Landscape and Climate

The landscape to a large degree reflects the shape of the underlying bedrock. The central core underlain by the softer sedimentary rocks has low relief, many wetlands, meandering streams, and minimal relief. The granitic terrain northeast of Magaguadavic Lake is much more rugged and hosts impressive features such as Blaney Ridge and Magundy Hill. The large granitic pluton around Lake Utopia and Digdeguash Lake is rimmed with a chain of small mountains that overlook the Bay of Fundy.

New Brunswick (left bank and islands) is separated from Maine (right bank) by the St. Croix River. Part of the Grassy Islands protected natural area is pictured here.

The areas of greatest relief result mainly from differential erosion of bedrock. Prominent features such as Tower Hill and Pleasant Ridge, for instance, represent isolated plugs of resistant Devonian granite that have intruded the softer Ordovician sedimentary rocks. The northwest-trending bedrock lineation also has affected the alignment of local rivers, lakes, roadways, and railway lines.

The height of land is situated so far north that all but the most northerly streams empty south in the Bay of Fundy, rather than into the Saint John River. The largest rivers are the St. Croix and Magaguadavic. The St. Croix River forms the western boundary of the ecodistrict and flows southeast through a series of lakes, wetlands, and rapids before reaching the St. Croix estuary at Passamaquoddy Bay. The Magaguadavic River begins at Magaguadavic Lake, then flows southeast to enter the Bay of Fundy at St. George. Following a nearly parallel path, the Digdeguash River originates just south of McAdam and empties into Passamaquoddy Bay near Bocabec.

Two lakes in the ecodistrict have developed some unsual features. Second Kedron Lake is one of only a few know lakes in the world with burrballs. Burrballs are round balls composed of organic debris such as leaves and twigs, fine silt, and sand. When the loose material collects in ripple marks on the lake bottom, the constant rolling action along the bottom can compact the debris into a perfect ball. Lake Utopia, contains saucer-shaped concretions made of iron and manganese called ‘cow patties’.

The ecodistrict's borders touch the Saint John River valley and the Fundy coast, and its western edge abuts the State of Maine. The highest points occur at Pleasant Ridge and Upper Magaguadavic, both at about 270 m. Elevations elsewhere are fairly low, ranging from 150 m in the north to sea level in the south.

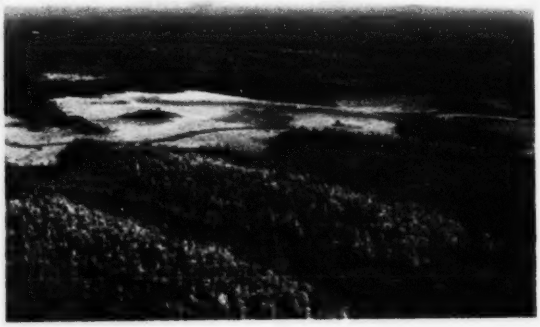
The higher ecodistricts to the northwest and east of Magaguadavic Ecodistrict help to give it a dry and warm climate. Its moderate elevations and largely inland location also prevent it from being overly affected by the cool, moist influence of the Bay of Fundy.

Soils

The dominant soils–the Thibault and Carleton units–are derived from calcareous sedimentary rocks and are concentrated in the low-lying central core. Loamy, non-compact soils of the Thibault Unit are common around McAdam and the Kedron lakes. Compact basal tills of the Carleton Unit also occur here, especially east of McAdam and southwest of Canoose Lake. These finely textured soils are silty loam to clay loam, and generally are poorly drained because of low relief.

Glaciofluvial deposits occur along the Magaguadavic and the Digdeguash rivers, with a large swath near Brockway. These deep, coarse-textured soils are associated with the Riverbank and Gagetown units. With their dry and nutrient-poor nature, they tend to support remnant white pine and red pine stands.

Several swamps and bogs have formed near Digdeguash River and are covered with Organic Unit soils. Other areas are overlain primarily by assorted soils of granitic and metasedimentary derivation.



The alignments of the landforms in this photo from the Canoose area reflect the direction of glacial advance in the last ice age (northwest to southeast).

Biota

Cedar is a dominant species here and occurs in many stand types ranging from flat, wet bogs to calcareous upper slopes. Various uncommon plants including colourful orchid species may be associated with these cedar stands. Black ash, red spruce, cedar, and red maple frequent the extensive bogs and swamps (3b) in the ecodistrict's central core.

Moist mid-slope terrains (5) support red spruce and balsam fir with white pine hemlock and cedar as the dominant softwood cover. Hemlock also occurs on cool, moist sites along rivers and lakes (2). The Grassy Islands in St. Croix River support an impressive stand of hemlock as well as a diversity of ecosystems including grasslands, shoreline forest communities and freshwater marshes.

Pure stands of white pine occur along upper reaches of the Magaguadavic River over areas of droughty, coarse-textured soils, and are visible for several kilometres where they straddle Highway 3 around Brockway. A mature red pine stand in the Brockway area is home to the eastern pine elfin and hoary elfin butterflies. The larval food of the eastern pine elfin is white pine and/or jack pine, whereas hoary elfin larvae eat mayflower.

Shade-tolerant forests of sugar maple, yellow birch, beech, and red oak are found on low ridgetop sites (8) such as Flume Ridge west of Big Kedron Lake and Blaney Ridge east of Magaguadavic Lake. An oak forest also grows over a dry acidic site at Woodland on the St. Croix River. The nearby rivershore at Spragues Falls is the only known setting in New Brunswick for common lousewort, now believed to have disappeared from Currie Mountain west of Fredericton.

Intolerant hardwood stands are dominated by red maple and trembling aspen with red spruce and balsam fir, suggesting an eventual transition to a tolerant, coniferous forest cover.

The plentiful bogs, lakes, and wetlands found in mid-ecodistrict contain a number of significant plants including the rare southern twayblade. Canoose Lake hosts the uncommon swamp fly-honeysuckle and the rare mermaid weed, and the margin of Kendricks Lake supports Atlantic manna-grass.

Sam Orr Pond receives infusions of saline water at high spring tides, which augments the pond's regular inflow of freshwater from surface drainage, yet allows it to retain enough heat to protect the only known population of quahogs in the Bay of Fundy. This warmer water species is normally restricted to the waters south of Cape Cod or to the Gulf of St. Lawrence.

Several interesting faunal species also rely on the wetlands and lakes for their habitat. New Brunswick's first documented sighting of crayfish was made at the confluence of Canoose Stream and the St. Croix River. A favourite destination for herpetologists is Twin Lakes north of Blueberry Mountain, where many species of New Brunswick amphibians and reptiles have been observed.

The St. Andrews headland is a crucial feeding and staging area for waterfowl and shorebirds. The St. Croix estuary adjoining and just above St. Andrews provides habitat for waterfowl and shorebirds, including American black duck, goldeneye, eiders, scoters, and bufflehead.

The St Croix River, like many salmon rivers in the province, has seen a decline in it's salmon population. Chamcook Lake is one of the deepest lakes in New Brunswick and has one of the few self-sustaining lake trout populations.

Settlement and Land Use

Magaguadavic Ecodistrict lies in traditional Passamaquoddy territory and encompasses the St. Croix River, which was a vital link in ancient overland portages between New England, the Bay of Fundy, and Saint John River valley.

For at least 2500 years, aboriginals occupied the shores of Passamaquoddy Bay and its inshore islands. Dozens of native encampment sites dated at 6000 to 7000 years old have been uncovered along the chain of rivers and lakes comprising the St. Croix river system bordering the ecodistrict. They relied on the area's game, shellfish, seabirds, fish, and other natural resources, and left behind hundreds of shell midden sites as testament to their lengthy presence.

The earliest Europeans were French settlers under Sieur de Monts. They spent the 1604-05 winter on St. Croix Island before leaving for the warmer climes of Annapolis Valley in Nova Scotia. Loyalists began to settle the coast in 1783 at places such as St. Andrews, St. George, and St. Stephen. Fishing, farming, logging, and sawmilling were the typical occupations.

The ecodistrict was the first in the province to be commercially exploited for timber, and reports indicate that by 1805 the forests had been heavily scoured. Some sixty sawmills were erected at St. Andrews, St. Stephen, along the Magaguadavic River, the Digdeguash River, and elsewhere.

The sawmill remained as an economic mainstay for the rest of the century, but subsequently were augmented by the St. George granite quarries and a textile mill in St. Stephen. The St. George quarries located in and around Lake Utopia produced some of the finest quality granite pillars and monumental stone in North America. They were active from 1872 until the 1930s.

The regional economy is currently sustained by forestry, tourism, blueberry farming, aquaculture, and commercial fishing.

This view of St. Andrew's-by-the-Sea includes Minister's Island in the background, and the historic Algonquin Hotel (left). *Photograph © Ron Garnett--AirScapes.ca.*

5.8 Magaguadavic Ecodistrict at a Glance

Ecoregion: Valley Lowlands

Area: 301, 809 ha

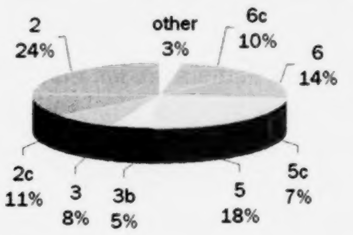
Average elevation above sea level: 115 m

Average May–September precipitation: 450 mm

Average annual degree-days above 5°C: 1600–1700

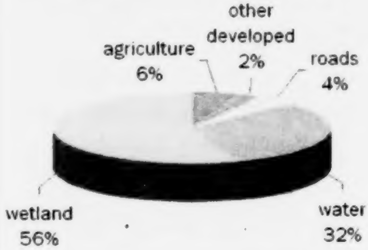
82% of Magaguadavic Ecodistrict has forest cover

ecosite coverage of forest area

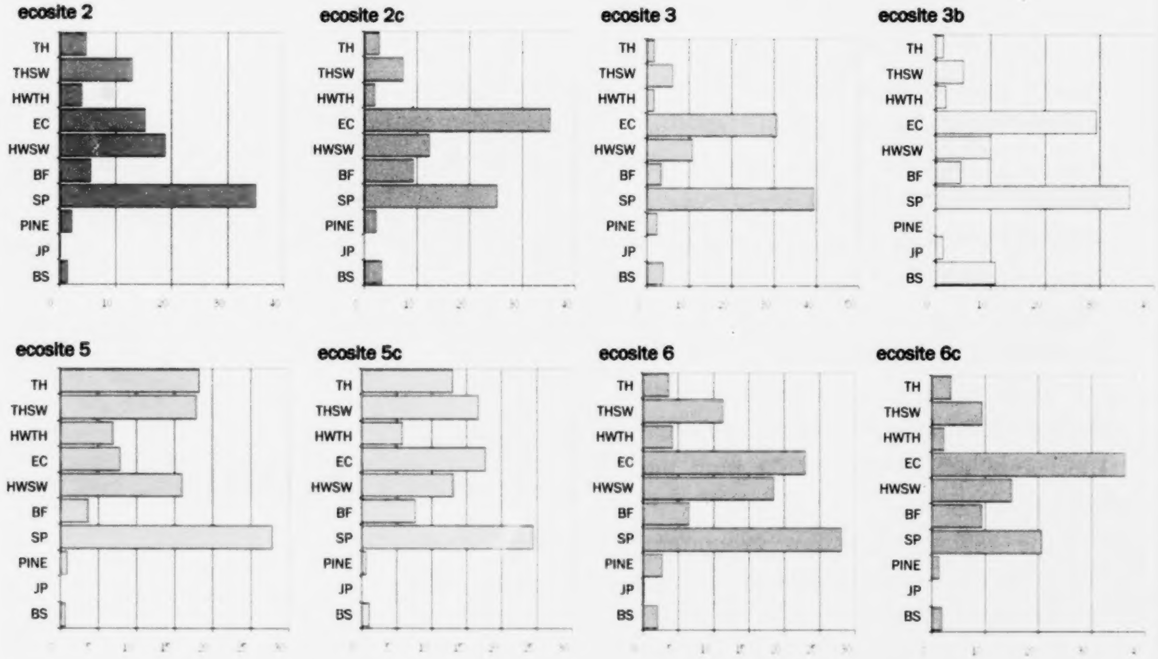


18% of Magaguadavic Ecodistrict is not forested

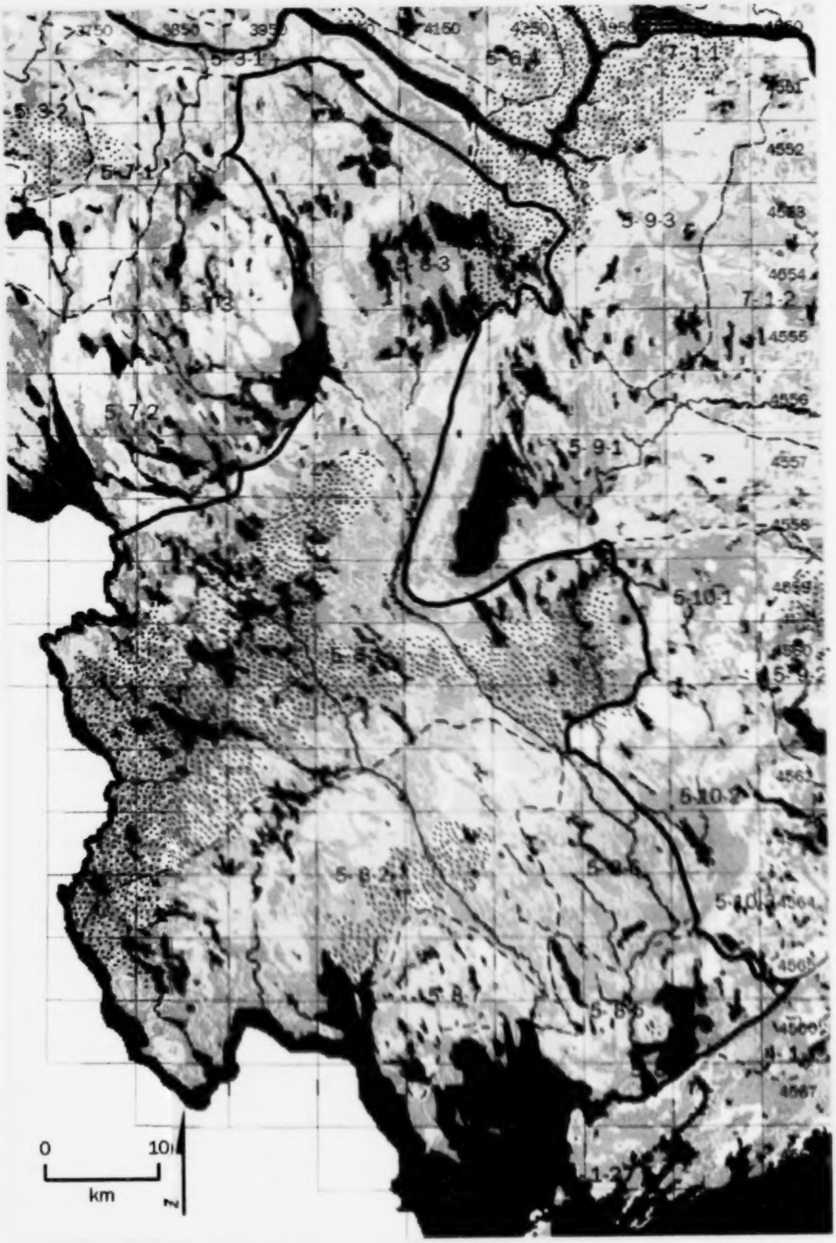
uses of non-forest area



Percent cover of forest stand types by ecosite



Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP-red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.


3750
3850
3950
4150
4250
4950
5-3-1
5-9-2
5-6-1
7-1-1
4551
4552
5-7-1
5-9-3
4553
5-8-3
4554
5-7-3
7-1-2
4555
5-7-2
4556
5-9-1
4557
4558
5-10-1
4559
5-8-1
4560
5-9
4561
5-10-2
5-8-2
5-8-6
5-10-3
4564
4565
5-8
5-8-5
4566
4567
1-2
0
10
km
N

Ecosite map legend

ecosite

- 1
- ▨ 2
- ▨ 3
- 4
- 5
- ▨ 6
- 7
- ▨ 8

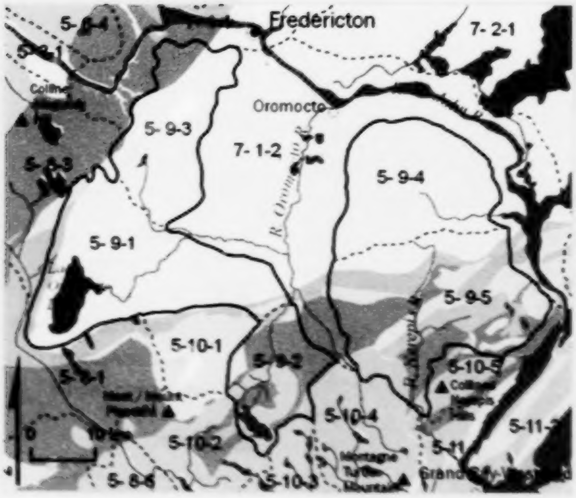
ecosite modifiers

- ⁘ c (calcareous)
- ■ o (organic)
- ≡ f (periodically flooded)
- ☐ h (high elevation)
- ⁘ m (mining debris)

- ■ water

5.9. Yoho Ecodistrict

The Yoho Ecodistrict is located in southern New Brunswick west of the Saint John River. It consists of two distinct upland areas separated by wetlands and tributaries of the broad Oromocto River.



Geology of Yoho Ecodistrict

Rock Types

Highly calcareous sedimentary

Calcareous sedimentary

Non-calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites

Geology

Rocks in the northern part of the ecodistrict possess a fairly uniform lithology with red and grey Pennsylvanian conglomerate, sandstone, siltstone, and shale belonging to the Cumberland Group. A small intrusion of felsic volcanic rocks occurs near the village of Harvey, where local roadcuts reveal the flow-banded rhyolite that underlies Harvey Mountain.

Rocks in the southern portion display a more complex assemblage. They are composed mainly of interbedded Silurian to Devonian mafic and felsic volcanic rocks, with assorted metasedimentary rocks. A narrow band of calcareous sedimentary rocks occurs between Sand Brook in the west and Petersville Hill in the east.

Silurian to Devonian granitic plutons also occur in the south, specifically in the vicinities of Evandale, Welsford, and South Oromocto Lake. The pink granitic cliffs just south of Welsford reach 66 m in height and are popular with rock-climbing enthusiasts.

Landscape and Climate

The landscape shifts gradually from low-lying, rolling relief in the north where rocks are easily eroded to higher, more rugged hills in the south where rocks are resistant. Wetlands are prevalent in the north, especially around Oromocto Lake, but are less common in the south.

Most rivers in the west drain into the Oromocto River, either directly or via the South Branch Oromocto River. Those in the east flow into the Oromocto or Saint John river systems. The landscape lacks well defined bedrock lineations or topographic constraints such as mountain valleys that would give strong direction to the waterways. Instead, the rivers meander across the terrain before reaching their watershed destination.

The relatively flat terrain and lack of major bedrock faulting has encouraged the formation of several lakes, the largest being Oromocto Lake, Yoho Lake, and South Oromocto Lake. The first two are bound by sedimentary strata, whereas the third is surrounded mainly by granite. South Oromocto Lake's granitic nature allows for cold waters with a sizeable brook trout population. Its acidic bedrock, however, has made the waters extremely sensitive to acid rain and snow.

Oromocto Lake is one of only two freshwater lakes in the province with saucer-shaped iron-manganese concretions in the bottom. The concretions are up to 15 cm in diameter, and occur on the glacier-formed ridges of sand and rock that characterize much of the lake bottom.

Although the ecodistrict lacks the dramatic mountains or steep valleys of more northerly regions, it has a number of interesting geographic features. The 274 m granitic peak of Logans Mountain is the highest point in the area, and perches 130 m above the surrounding landscape to offer a fine vista over nearby South Oromocto Lake. A 100 m escarpment called Shaving Ridge occurs along the southwest boundary near Oromocto Lake, and appears to define the contact between separate formations of the Cumberland Group.

As well, the South Branch Oromocto River possesses a spectacular gorge. The river here races through a canyon, crashes over beds of steeply dipping Devonian sandstone in a turbulent waterfall, then battles downstream through a chain of rapids to finally reach the Oromocto River beyond.

The ecodistrict lies in the rain shadow of the Cranberry Ecodistrict uplands to the west, and consequently has a dry and warm climate. The growing season and summer precipitation data are similar to those of the Eastern Lowlands Ecoregion.

Soils

The dominant soils are compact basal tills derived from red Pennsylvanian sedimentary rocks. Of these, the finer textured soils—sandy clay loams to clay loams of the Stony Brook Unit—are most common, whereas the medium-textured soils of the Tracy and Harcourt units are more scattered. These acidic soils tend to be poorly drained, except on ridges and in scattered patches containing the sandy and shallow soils of the Fair Isle Unit.

The greyer sandstones have produced basal tills of the Reece Unit, which appear intermixed with coarse-textured, bouldery ablation tills of the Sunbury Unit around Oromocto Lake.

Calcareous sedimentary strata transect the landscape in the south and have produced fertile, well drained loamy soils. They belong to the Carleton and Thibault units, and occur in the vicinities of Juvenile Settlement and Pleasington. Calcareous soils also occur around Harvey and Inchby Ridge, where red, compact loams and sandy loams of the Parry and Salisbury units sustain the most arable land in the region.

The least fertile soils are associated with areas of volcanic and metasedimentary rocks, and belong to the Mafic Volcanic, Lomond and Serpentine units. They are shallow and stony with limited agricultural capacity. Soils of the Mafic Volcanic Unit are typically less acidic and are associated with species rich plants communities.

Biota

The ecodistrict has been highly disturbed by intensive settlement, logging activities, and military training at Canadian Forces Base Gagetown. The resulting early successional forest is prevalent across the landscape, and is composed of red maple, white and grey birch, and trembling aspen.

Elsewhere, a typical Valley Lowlands forest occurs on well drained, mid-slope areas of less disturbance, and is composed of red spruce, balsam fir, and hemlock with red maple (5). Red oak and red pine are found more infrequently various soil types. Black spruce, red spruce, balsam fir, and cedar are widespread on poorly drained soils (3, 6).

A mixed community of beech, sugar maple, yellow birch, red spruce, balsam fir, and white pine occasionally occurs on exposed ridgetops (8). Yellow birch and sugar maple are more abundant on well drained areas of calcareous soils. Poorer quality hardwood stands dominated by beech and sometimes red oak occupy the highly acidic upper slopes (7, 8), whereas hemlock, red spruce, white pine, and red oak sometimes occupy the lower slope positions and shallow soils (2). Several natural, pure stands of red oak and red pine grow on moderately well drained, loamy soils.

Several of the interesting or rare plants here are associated with lakes. One such shallow-water, boreal lake supports two intriguing quillworts: Tuckerman's quillwort and the rare Acadian quillwort. The lake also hosts the newly identified prototype quillwort that has been found only in Lakes in New Brunswick, Nova Scotia, and Maine. The prototype quillwort was designated as *of Special*

Concern by COSEWIC (Committee on the Status of Endangered Wildlife in Canada) in 2005.

Yoho Lake is one of only a few known locations in New Brunswick to support Robbin's spikerush. Clammy hedge-hyssop or small-flowered, gratiola also grows in wetlands near the lake's outlet.

Settlement and Land Use

The ecodistrict straddles traditional Maliseet and Passamaquoddy territory. Aboriginals used the land regularly for hunting, fishing and trapping expeditions, as well as for overland travel between the Saint John River valley and Passamaquoddy Bay.

The first permanent non-aboriginal settlements were established in the early 1800s, and their names reveal the immigrants' origins. Cork (also known as Teetotal Settlement) was established by Irish from Fredericton who had taken the pledge before leaving Ireland. Tweedside was named by its Scottish inhabitants. The village of Germany was home to German immigrants with the surnames of Knorr, Fromm, and Schenk.

Several villages in the eastern half of this ecodistrict were expropriated in the mid-1950s when the Canadian government created the military base at Camp Gagetown. Driving through the base, one can still see graveyards of these former communities, their faded headstones dating back to the mid-1800s.

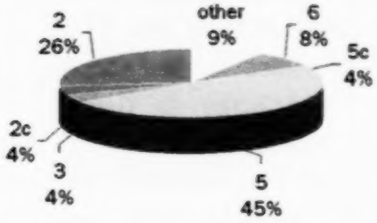
Coal outcrops occur throughout the Pennsylvanian strata, but coal has not been mined here to any degree. Deposits of tin, silver, iron, molybdenum, lead, zinc, and other metallic minerals are associated with the granitic and volcanic rocks, but to date have not been commercially developed. Forestry remains a mainstay of the local economy.

5.9. Yoho Ecodistrict at a Glance

Ecoregion: Valley Lowlands
Area: 208, 412 ha
Average elevation above sea level: 60 m
Average May–September precipitation: 400–450 mm
Average annual degree-days above 5°C: 1600–1800

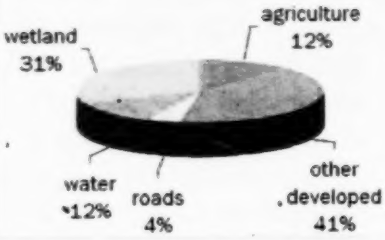
77% of Yoho Ecodistrict has forest cover

ecosite coverage of forest area



23% of Yoho Ecodistrict is not forested

uses of non-forest area

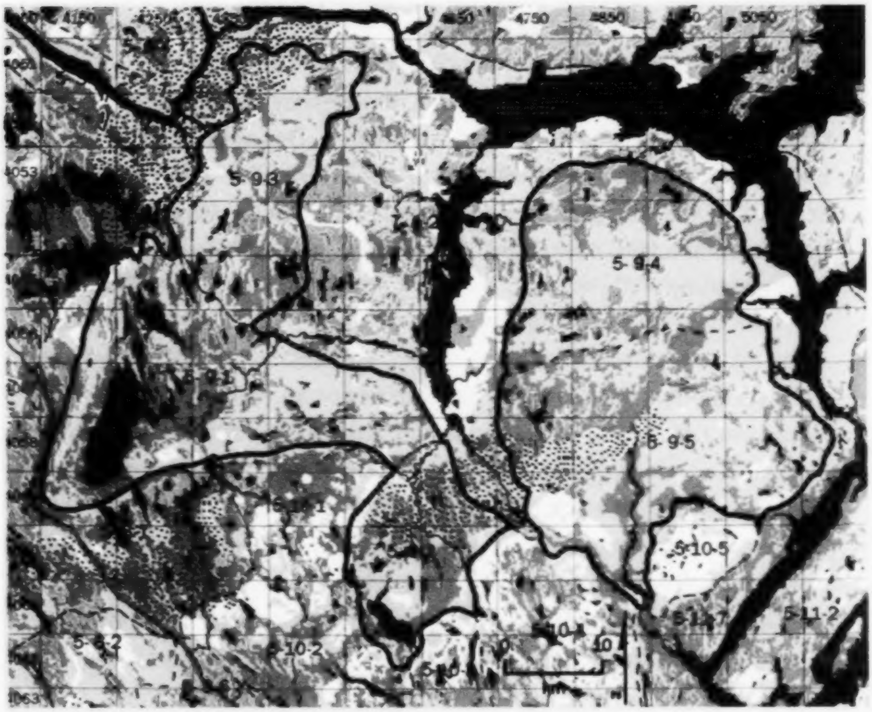


Ecosite map legend

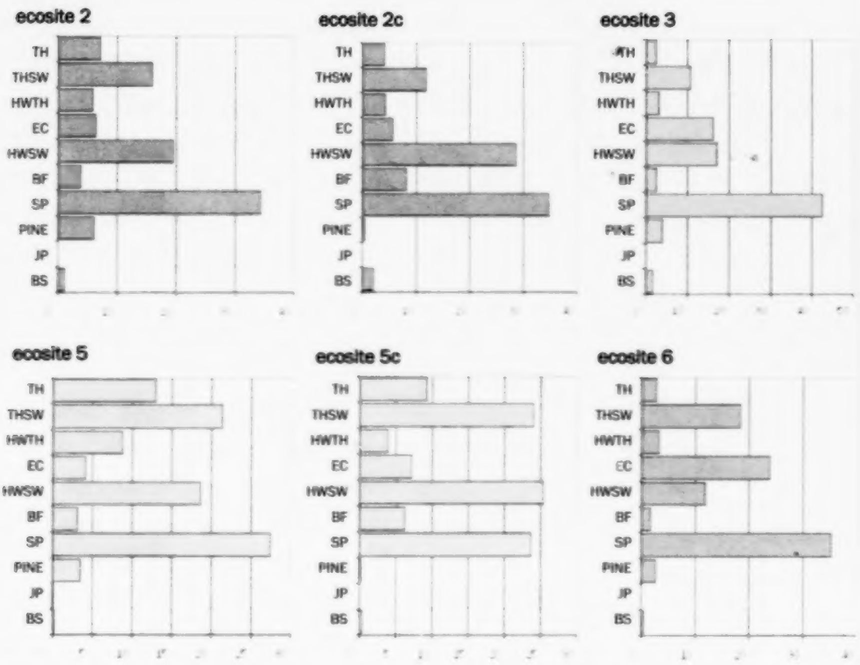
ecosite
- 1
- ▨ 2
- ▨ 3
- 4
- ▨ 5
- ▨ 6
- 7
- ▨ 8

ecosite modifiers
- ▨ c (calcareous)
- ■ o (organic)
- ▤ f (periodically flooded)
- ☐ h (high elevation)
- ▨ m (mining debris)

- ■ water


4150
4250
4750
4850
5050
5-9-3
5-9-4
5-9-1
5-9-5
5-10-1
5-10-5
5-8-2
5-10-2
5-10-4
5-11-7
5-11-2
0
10
km

Percent cover of forest stand types by ecosite



Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce. **Horizontal axis**: percent cover.

5.10. Mount Pleasant Ecodistrict

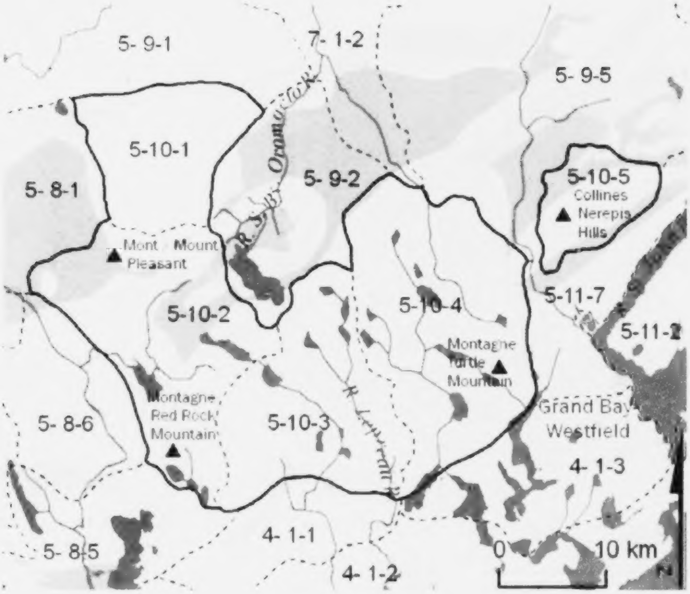
The Mount Pleasant Ecodistrict is located in southwest New Brunswick west of the Saint John River. It consists of an eastern and a western segment that are separated by a short section of the Nerepis River.

Geology

The western area of the ecodistrict is underlain primarily by Devonian granites and granodiorites belonging to the St. George Batholith. An area of Devonian granitic, volcanic, and sedimentary rocks fills the northern lobe.

Between the granitic and felsic volcanic rocks is a small zone of Ordovician to Silurian metasedimentary rocks that include carbonaceous to non-carbonaceous shale, siltstone, and greywacke.

The much smaller eastern segment contains Silurian granites and sedimentary rocks; the latter are composed of non-calcareous



Geology of Mount Pleasant Ecodistrict

Rock Types

- Highly calcareous sedimentary
- Calcareous sedimentary
- Non calcareous sedimentary
- Early Carboniferous sedimentary
- Late Carboniferous sedimentary
- Mafic volcanic
- Felsic volcanic
- Granites and granodiorites

sandstone, siltstone, and conglomerate.

Landscape and Climate

The ecodistrict displays a strongly rolling plateau of rugged granite, perched above the lower, flatter terrain of adjoining ecodistricts. The granitic rock is relatively impervious to water and consequently is covered with many lakes that fill depressions in the landscape.

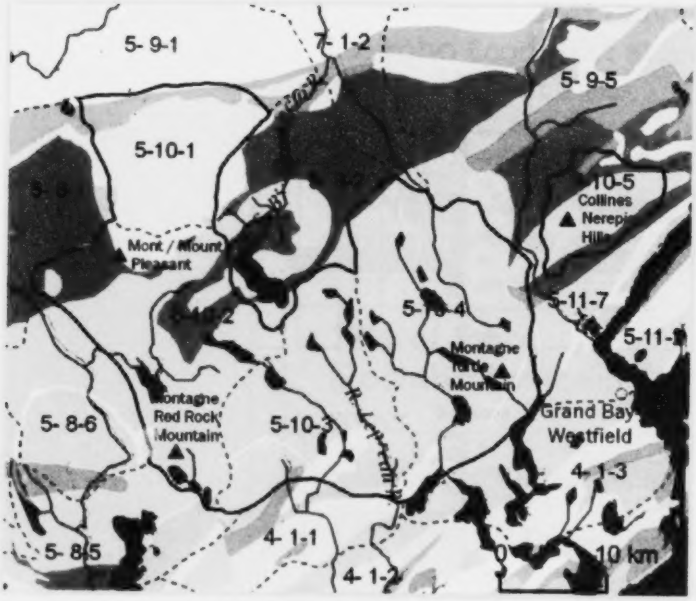
The lakes' names reflect a miniature natural and cultural history of the region: Moose Lake, Loon Lake, Trout Lake, Turtle Lake, Eagle Lake, Mosquito Lake, Crystal Lake, Coronary Lake and Disappointment Lake. The last-named body of water formerly was called Mistake Lake, and in Passamaquoddy was known as *Esquagamook* or *end lake* in reference to its location at the head of Lepreau River.

Most rivers in the western segment arise from one or other of the lakes and flow southward directly into the Bay of Fundy. One of the few exceptions is the Piskahegan River in the north, which heads north out of the highlands towards the Magaguadavic Ecodistrict, then angles abruptly south to join the Magaguadavic River. Rivers in the eastern segment drain from the granitic Nerepis Hills into the Nerepis River, which enters the Saint John River at Woodmans Point outside the ecodistrict.

The eastern section of the ecodistrict rises 120 m to 220 m above the surrounding lowlands; hills in the western section sit 75 m above the surrounding terrain, but attain an elevation of 330 m.

This climate is relatively warm and moist. Its growing season and precipitation are intermediate between those in the drier, warmer Grand Lake Ecoregion to the northeast and the colder, wetter Fundy Coast Ecoregion to the south. During the summer, fog from the bay frequently extends into the ecodistrict, possibly creating favourable conditions for the dense red spruce regeneration seen in many clearcut areas.

sandstone, siltstone, and conglomerate.



Geology of Mount Pleasant Ecodistrict

Rock Types

Highly calcareous sedimentary
Calcareous sedimentary
Non-calcareous sedimentary
Early Carboniferous sedimentary
Late Carboniferous sedimentary
Mafic volcanic
Felsic volcanic
Granites and granodiorites

Landscape and Climate

The ecodistrict displays a strongly rolling plateau of rugged granite, perched above the lower, flatter terrain of adjoining ecodistricts. The granitic rock is relatively impervious to water and consequently is covered with many lakes that fill depressions in the landscape.

The lakes' names reflect a miniature natural and cultural history of the region: Moose Lake, Loon Lake, Trout Lake, Turtle Lake, Eagle Lake, Mosquito Lake, Crystal Lake, Coronary Lake and Disappointment Lake. The last-named body of water formerly was called Mistake Lake, and in Passamaquoddy was known as *Esquagamook* or *end lake* in reference to its location at the head of Lepreau River.

Most rivers in the western segment arise from one or other of the lakes and flow southward directly into the Bay of Fundy. One of the few exceptions is the Piskahegan River in the north, which heads north out of the highlands towards the Magaguadavic Ecodistrict, then angles abruptly south to join the Magaguadavic River. Rivers in the eastern segment drain from the granitic Nerepis Hills into the Nerepis River, which enters the Saint John River at Woodmans Point outside the ecodistrict.

The eastern section of the ecodistrict rises 120 m to 220 m above the surrounding lowlands; hills in the western section sit 75 m above the surrounding terrain, but attain an elevation of 330 m.

This climate is relatively warm and moist. Its growing season and precipitation are intermediate between those in the drier, warmer Grand Lake Ecoregion to the northeast and the colder, wetter Fundy Coast Ecoregion to the south. During the summer, fog from the bay frequently extends into the ecodistrict, possibly creating favourable conditions for the dense red spruce regeneration seen in many clearcut areas.

Soils

The dominant soils are coarse-textured material derived from granitic and sedimentary ablation deposits. Two large glaciofluvial deposits of the Gagetown Unit are found near McDougall Lake and north of Mosquito Lake along the Lepreau River. Similarly coarse soils of the Juniper and Irving units occur as deep ablation deposits lining the bottom of broad valleys. All of these soils support slow-growing red spruce, red pine, red maple, and white birch. In some valley bottoms, the soils consist wholly of coarsely shattered bedrock. This is one of the few localities in New Brunswick where an open woodland community dominated by low shrubs and lichens develops naturally.

Residual, shallow soils of the Big Bald Mountain Unit cap many of the higher hilltops. Compact basal tills of the Tuadook and Catamaran units are less common, but they have a higher percentage of sedimentary clasts, a relatively fine texture, and a greater capacity to hold water. As a result, they tend to be more productive and support a greater diversity of flora and fauna. The best soils in the district belong to the Parry, Salisbury, Thibault, and Carleton units, which line the northern edge of the ecodistrict.

Biota

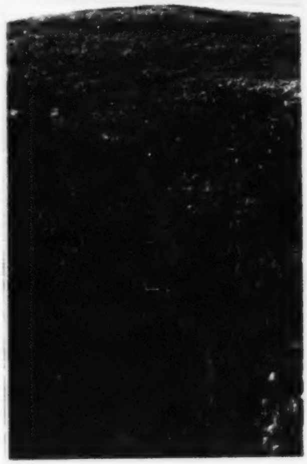
The landscape here is dominated by red spruce that is in association with red maple, white birch, and balsam fir.

Dry hilltops and upper slopes (7, 8) are capped by tolerant hardwood stands of beech, sugar maple, and red maple with occasional red spruce, ironwood, and white ash. These communities are particularly common in the Nerepis Hills.

The drier mid-slopes (4) have more tolerant hardwoods and less balsam fir than do the moist mid-slopes (5). Coarse-textured, lower slopes (1) and moist flatlands (2) tend to contain over 80% softwood species, mainly red spruce, black spruce, and pine.

Remnant red pine stands are found on lower sandy or stony soils. The frequency of fire-adapted species such as red pine and white pine, together with widespread low blueberry and teaberry suggests either a history of frequent fires across the area, or poor, acidic soil conditions that allow these typically fire-adapted species to reproduce in the absence of fire.

Areas disturbed by tree harvesting are dominated by intolerant hardwoods, particularly white birch, grey birch, red maple, and trembling aspen; many of these areas lie along major rivers that



The Piskahegan Stream tumbles southward toward its confluence with the Magaguadavic River. Beech Hill rises in the background.

The Nerepis Hills rise abruptly on the east side of the Nerepis River Valley. The Lepreau Ecodistrict occupies the plateau, while the river is situated in the Yoho Ecodistrict. *Photograph © Ron Garnett–AirScapes.ca.*

provided easy access to the forest lands.

Black spruce occurs on poorly drained soils (3) with red spruce, balsam fir and red maple, but cedar and tamarack are uncommon on these sites. The bog at Little Tomoowa Lake Protected Natural Area provides an example of the variation in peatland vegetation. Its vegetation pattern shifts from rooted aquatic plants through to floating sphagnum moss and eventually to a stunted forest of black spruce and tamarack. Another bog, just south of this site, suggests a coastal influence as evidenced by the presence of cloudberry and crowberry. In New Brunswick, these plant species typically are restricted to coastal peatlands and headlands.

The lakes here support a variety of wildlife, and bald eagles, have taken up residence in a number of large lakeside trees in the ecodistrict. Two of the more pristine lakes are Lake Anthony and Clear Lake. West Long Lake is one of the few lakes in the province with a self-sustaining lake trout population.

Settlement and Land Use

Mount Pleasant Ecodistrict straddles the traditional territories of the Maliseet and Passamaquoddy. The area was used for hunting and trapping expeditions, and for overland travel to the Oromocto River system. A native village apparently was located just beyond the ecodistrict at the confluence of the Saint John and Nerepis rivers.

The area seems to have had very little "settlement appeal", as it has virtually no historic or modern settlements. The windswept, non-arable granitic terrain likely discouraged anyone who had a choice of living along the far more hospitable Fundy Coast or Saint John River valley. Due to its lack of settlements and poor access, the area has received less attention from naturalists and many interesting finds await here.

Economic mineral deposits are found here along intrusive contacts

Conifer plantations are extensive in the Mount Pleasant Ecodistrict.

between granitic plutons and older rocks, or within the plutons themselves. A wide range of metallic and non-metallic minerals have been discovered: tin, tungsten, bismuth, copper, molybdenum, lead, silver and gold, to name a few. To date, only the Mount Pleasant deposit has been mined. It also holds the world's largest known reserves of indium, a rare earth element used to produce coating agents for computer screens.

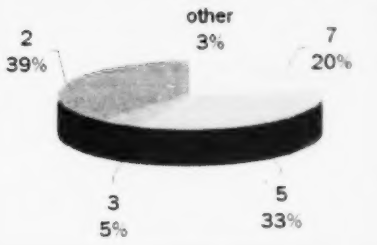
Forestry is an important activity in the area that since the late 1970s has created much new road access. Forest tracts here are divided mainly between large industrial freehold land and Crown land.

5.10. Mount Pleasant Ecodistrict at a Glance

Ecoregion: Valley Lowlands
Area: 117, 632 ha
Average elevation above sea level: 185 m
Average May-September precipitation: 475–500 mm
Average annual degree-days above 5°C: 1700–1800

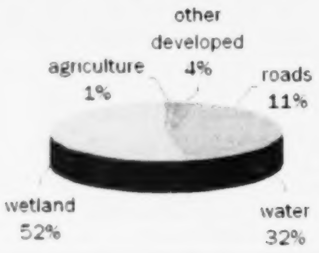
89% of Mount Pleasant Ecodistrict has forest cover

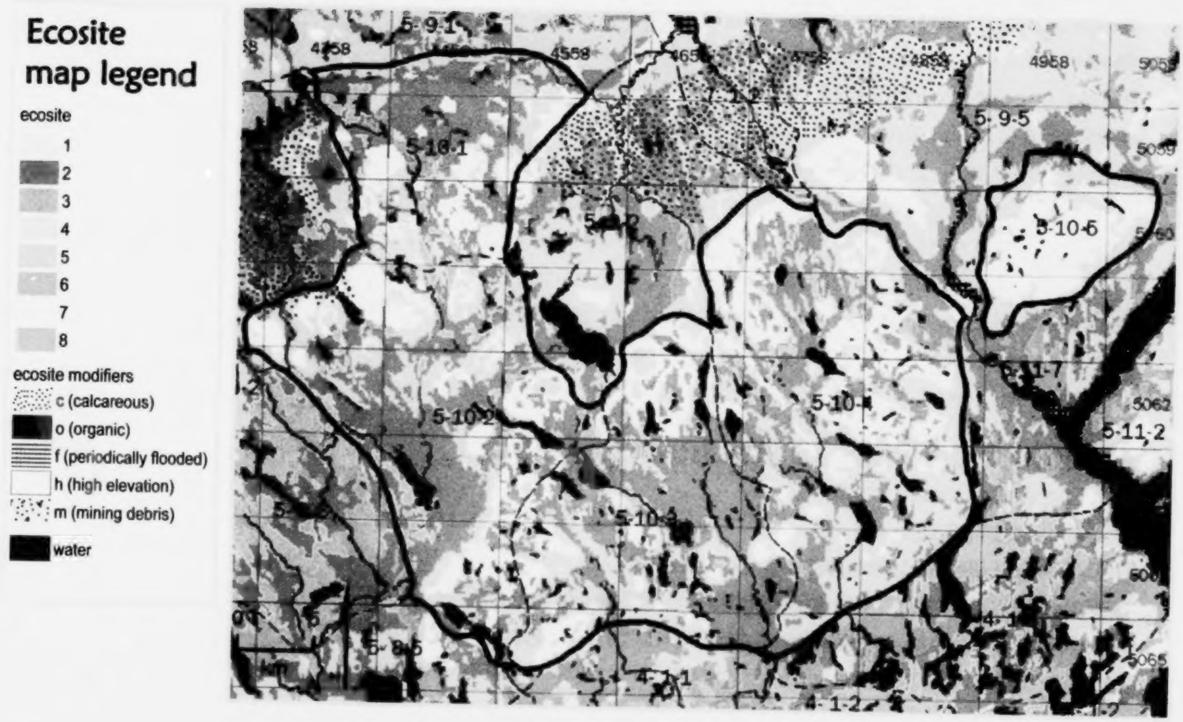
ecosite coverage of forest area



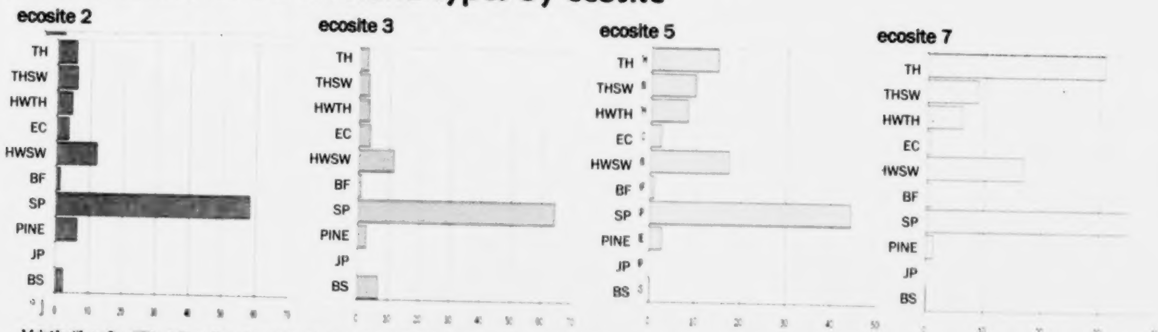
11% of Mount Pleasant Ecodistrict is not forested

uses of non-forest area




Ecosite map legend
ecosite
1
2
3
4
5
6
7
8
ecosite modifiers
c (calcareous)
o (organic)
f (periodically flooded)
h (high elevation)
m (mining debris)
water
5-9-1
4458
4558
4658
4758
4858
4958
5058
5-9-5
5-10-1
5-10-2
5-10-4
5-10-5
5-11-7
5062
5-11-2
5-10-3
5-8-5
4-1-1
4-1-2
5065

Percent cover of forest stand types by ecosite



Vertical axis: TH—tolerant hardwood species; THSW—tolerant hardwood with softwood species; HWTH—intolerant hardwood and tolerant hardwood species; EC—eastern white cedar; HWSW—intolerant hardwood and softwood species; BF—balsam fir; SP–red or white spruce; PINE—white pine; JP jack pine; BS—black spruce **Horizontal axis**: percent cover.

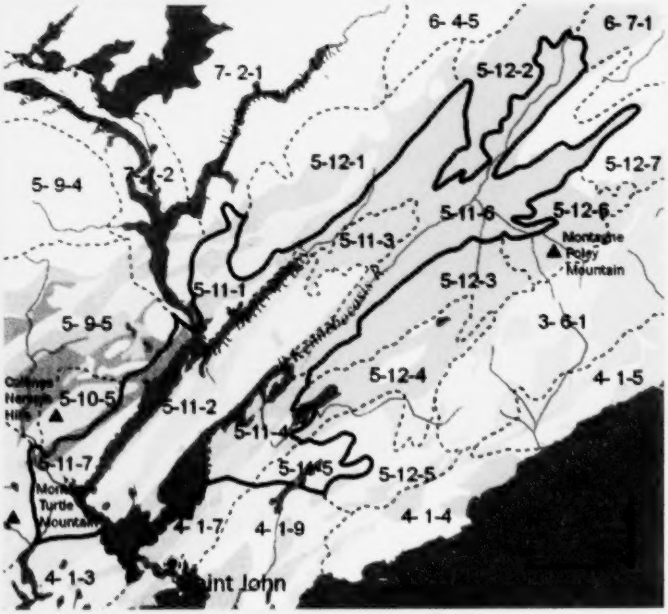
5.11. Kingston Ecodistrict

The Kingston Ecodistrict is situated in southern New Brunswick in the lower Saint John River valley. It straddles the Kingston Peninsula, and the valleys of Kennebecasis Bay, Kennebecasis River, Belleisle Bay, and Long Reach.

Geology

Bedrock from the northeast border of this ecodistrict down to about Norton is dominated by red to grey Mississippian sedimentary rocks. They include sandstone, conglomerate, siltstone, and mudstone with minor evaporites such as limestone, halite (salt), and potash. The presence of limestone is reflected in small pockets of karst terrain; salt springs in the Sussex area reveal halite (salt-bearing) deposits below surface.

Precambrian igneous and sedimentary rocks occur near Rothesay include limestone of the Green Head Group which, at about 1 billion years old, are the oldest rocks in the province. The Kingston Peninsula also is underlain by Precambrian or younger volcanic rocks, Mississippian red sedimentary rocks and Silurian granites. A similar rock assemblage occurs near Nerepis on the west shore of the Saint John River.



Geology of Kingston Ecodistrict

Rock Types

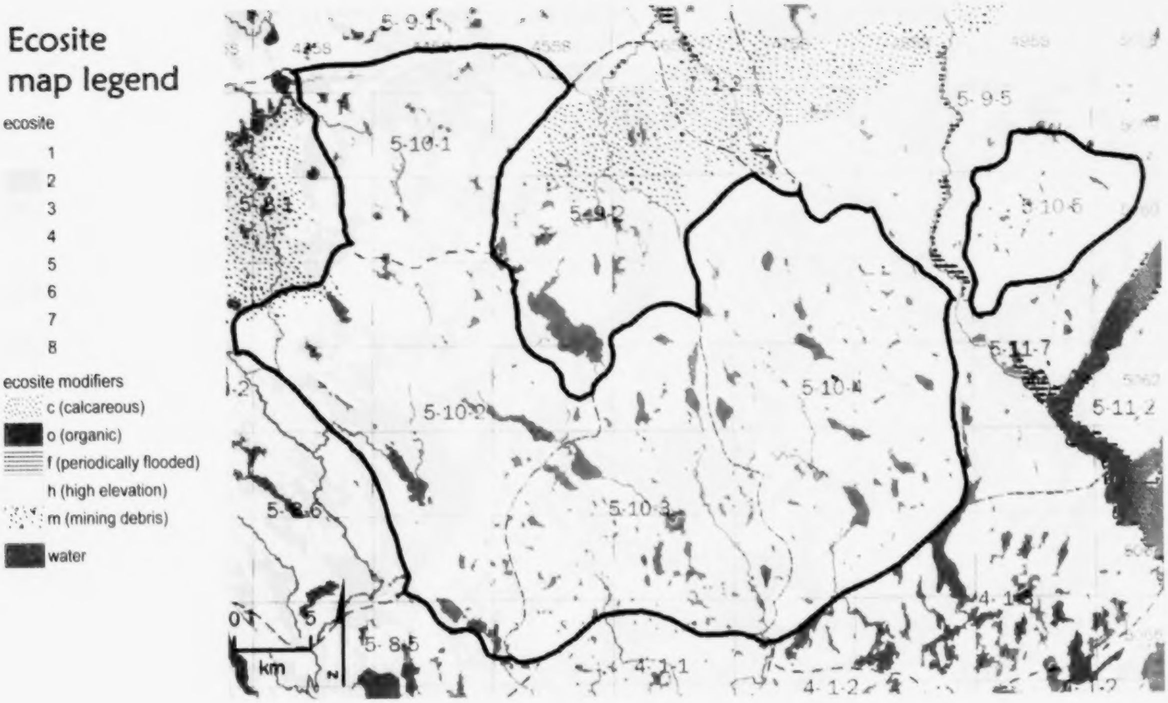
Highly calcareous sedimentary
Calcareous sedimentary
Non-calcareous sedimentary
Early Carboniferous sedimentary
Late Carboniferous sedimentary
Mafic volcanic
Felsic volcanic
Granites and granodiorites

The extensive, northeast-trending Belleisle Fault transects the ecodistrict. Both Belleisle Bay and Long Reach owe their existence to this major structural lineament, which is clearly visible as a rusty, brecciated zone in a roadcut on Highway 7 opposite Long Reach.

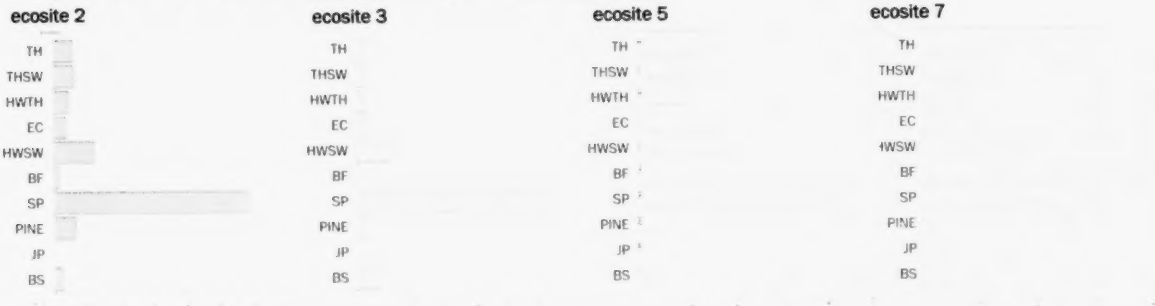
The Hampton area exemplifies the geological scope in the ecodistrict. A person standing on Highway 1 near Hampton can see red conglomerate beside the road, then glance northward at Precambrian volcanic hills. About 600 million years ensued between formation of the volcanic rocks and the younger conglomerates.

Landscape and Climate

The landscape is dominated by the Kennebecasis and Belleisle


Ecosite map legend
ecosite
1
2
3
4
5
6
7
8
ecosite modifiers
c (calcareous)
o (organic)
f (periodically flooded)
h (high elevation)
m (mining debris)
water
5-9-1
2-2
5-9-5
5-10-1
5-8-1
5-9-2
5-10-5
5-11-7
5-10-4
5-11-2
5-10-2
5-10-3
5-8-6
5-8-5
4-1-1
4-1-2
4-1-3
0
5
km
N

Percent cover of forest stand types by ecosite



Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.

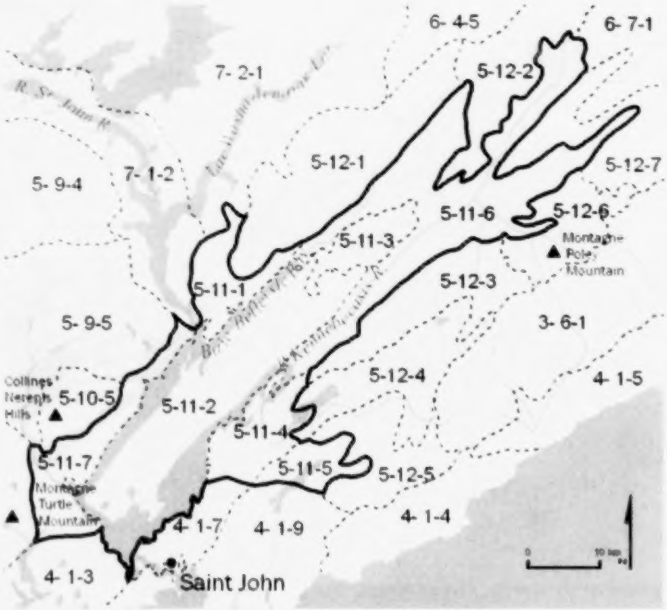
5.11. Kingston Ecodistrict

The Kingston Ecodistrict is situated in southern New Brunswick in the lower Saint John River valley. It straddles the Kingston Peninsula, and the valleys of Kennebecasis Bay, Kennebecasis River, Belleisle Bay, and Long Reach.

Geology

Bedrock from the northeast border of this ecodistrict down to about Norton is dominated by red to grey Mississippian sedimentary rocks. They include sandstone, conglomerate, siltstone, and mudstone with minor evaporites such as limestone, halite (salt), and potash. The presence of limestone is reflected in small pockets of karst terrain; salt springs in the Sussex area reveal halite (salt-bearing) deposits below surface.

Precambrian igneous and sedimentary rocks occur near Rothesay include limestone of the Green Head Group which, at about 1 billion years old, are the oldest rocks in the province. The Kingston Peninsula also is underlain by Precambrian or younger volcanic rocks, Mississippian red sedimentary rocks and Silurian granites. A similar rock assemblage occurs near Nerepis on the west shore of the Saint John River.


6-4-5
6-7-1
7-2-1
5-12-2
R. Saint John R.
5-12-1
5-9-4
7-1-2
5-12-7
5-11-6
5-12-6
Montagne Pole Mountain
5-11-3
5-11-1
5-12-3
5-9-5
3-6-1
Belleisle Bay
Kennebecasis R.
Collines Nerepis Hills
5-10-5
5-11-2
5-12-4
4-1-5
5-11-4
5-11-7
5-11-5
5-12-5
Montagne Turtle Mountain
4-1-7
4-1-9
4-1-4
4-1-3
Saint John
0
10 km

Geology of Kingston Ecodistrict

Rock Types

- Highly calcareous sedimentary
- Calcareous sedimentary
- Non-calcareous sedimentary
- Early Carboniferous sedimentary
- Late Carboniferous sedimentary
- Mafic volcanic
- Felsic volcanic
- Granites and granodiorites

The extensive, northeast trending Belleisle Fault transects the ecodistrict. Both Belleisle Bay and Long Reach owe their existence to this major structural lineament, which is clearly visible as a rusty, brecciated zone in a roadcut on Highway 7 opposite Long Reach.

The Hampton area exemplifies the geological scope in the ecodistrict. A person standing on Highway 1 near Hampton can see red conglomerate beside the road, then glance northward at Precambrian volcanic hills. About 600 million years ensued between formation of the volcanic rocks and the younger conglomerates.

Landscape and Climate

The landscape is dominated by the Kennebecasis and Belleisle reaches of Saint John River which, together, define the perimeter of the Kingston Peninsula.

The Kennebecasis Reach begins as Kennebecasis Bay, then narrows into the Kennebecasis River. The river in turn splits into Millstream River, Smith Creek, and Upper Kennebecasis River, which drain three eastern lobes of the ecodistrict. The northern reach originates as Long Reach, then angles around Shampers Bluff to become Belleisle Bay. Shampers Bluff is a beautiful location with a peaceful aspect, and shelters one of two known New Brunswick occurrences of the small-flowered bitter cress.

The Kennebecasis and Belleisle valleys feature perched hills, valleys, cliff faces, and swift streams. Their resistant volcanic rock interbedded with less resistant sedimentary rock makes for a dramatic landscape that owes much to differential erosion. The Kennebecasis hills have been the subject of many paintings by the famous Saint John artist, Jack Humphrey.

The northeast segment around Sussex has a lower relief that is more rolling than rugged. The countryside here reveals pastoral vistas that have enchanted visitors since the early 1800s, and its gentle hills sustain one of the most intensively farmed regions of the province.

The highest elevation of 220 m occurs at Raymond Mountain north of Bloomfield.

The region has a relatively dry and warm climate that becomes even warmer as one moves north away from the Bay of Fundy and toward upper reaches of the Kennebecasis.

Soils

The northeast area is overlain mainly by soils derived from red and grey sedimentary rocks. These slightly calcareous, sandy loams have variable texture and belong to the Salisbury, Saltsprings, and Parry forest soils. They tend to have impeded drainage on flat terrain but, where well drained to moderately well drained, they represent the most fertile land in the ecodistrict and typically have been cleared for agriculture.

The upper reaches of the Kennebecasis River and its tributaries are lined in places by fertile alluvial soils of the Interval Unit. The same area contains zones of coarse-textured, gravelly glaciofluvial deposits of the Gagetown and Kennebecasis units. These acidic, dry soils are better suited to drought-tolerant pines.

Shallow, medium-textured soils of the Lomond and Popple

Depot units are derived from a mixture of igneous and sedimentary rocks and cover much of the Kingston Peninsula. They are composed of loams to silty loams with a high gravel component, and are somewhat acidic but suitable for mixed farming where slopes are favourable.

Biota

Nearly 60% of the land area supports intolerant hardwood stands, active farmland, or inactive agricultural fields, a consequence of nearly three centuries of concentrated human activity. The dominant softwood cover of white spruce and balsam fir with some red spruce (5, 7) is most apparent where fields have been abandoned for many decades.

Cedar is locally abundant on sites with calcareous soils (6c). The damp soils of Lower Kars Stream on Belleisle Bay, sustain a community of cedar and black ash with an understorey of orchids, trillium, and the Eurasian orchid helleborine. The moist rocky ledges along the stream harbour the first known New Brunswick locality of Virginia mountain mint. Large colonies of the rare whorled loosestrife grow farther down the bay on the south shore of Long Reach near Westfield.

Jack pine, white pine, and red pine tend to prefer gravelly, sandy soils along rivers and streams (1), or dry escarpments. The Rockville escarpment on Trout Creek hosts a stand of white and red pine with some jack pine and red oak. The very rare rock spikemoss also occurs on cliffs at this site.

Tolerant hardwood stands composed of beech, sugar maple, red maple, and yellow birch with some red spruce occupy hilltops along the few uncleared river slopes and ridgetops (5, 7). White ash and ironwood with some oak often accompany these stands and become the dominant overstorey species in a few dry, ridgetop locations.

The understorey at Hampton Ridge hosts a high diversity of rare or unusual plants. Skunk cabbage, white baneberry, and small purple-fringed orchid all grow on the ridge itself, or along the adjacent floodplain area.

Perhaps the most exotic flora are those associated with the Sussex salt springs. Near Sussex, the saline soil environment has been preserved by localized salt springs, which today support several species with a saline affinity: toad rush, chickenclaws or glasswort, and coastal salt grass.

Kingston Ecodistrict also features a number of wetlands with significant bird habitat. Grassy Island near Oak Point on the Saint John River was the first confirmed breeding site for Wilson's phalarope in the Maritimes. The island and neighbouring floodplain areas are also unique in hosting a recently established breeding population of greater scaup. Common tern and assorted gulls also nest here.

The Hampton marsh extends from Darlings Island to Bloomfield. It embraces the backwaters and baylets of the Kennebecasis River, and is one of the most species-diverse wetlands in New Brunswick.

Settlement and Land Use

Kingston Ecodistrict lies within traditional Maliseet territory. Archaeologists have uncovered evidence of habitation dating back at least 3500 years. Important aboriginal settlements were located at Apohaqui, the Hammond River mouth, and elsewhere, where marshes and rivers provided abundant fish, waterfowl, game, and other food sources. The present-day village of Milkish in this ecodistrict was named after the Maliseet word *amilkesh* meaning *preserving place*, and lies close to where the Maliseet dried their fish.

The name *Apohaqui* is derived from a Maliseet word meaning *the junction of two streams*–in this case, the Millstream and Kennebecasis rivers.

The Kennebecasis River valley received its first European immigrants in the 1600s and, within a century, was densely populated. Unlike other ecodistricts where early settlements seldom ventured beyond the banks of waterways, villages in the Kennebecasis Valley formed one long eastward chain that almost met the string of villages flanking the Petitcodiac River.

The landscape was cleared and farmed so early and intensively that a visitor to Sussex in the 1850s was able to praise its "air of a civilised, old settled region". Shortly after his visit, the valley became transected by one of the first provincial railroads: the European and North American Railway between Saint John and Shediac.

The Trout River winds its way toward its confluence with the Kennebecasis river in this scene near Sussex Corner. *Photograph © Ron Garnett–AirScapes.ca.*

For many years, Sussex-made cheese and butter became famous across Canada and was flavoured with salt extracted from the Sussex salt springs.

Commercial logging began in the late 1700s, although timber volumes never approached anything like the tonnages removed from the Restigouche or Miramichi ecodistricts. The majority of all forest lands in the area today are privately owned by non-industrial woodlot owners.

Prospectors working in the region discovered, and occasionally developed, deposits of salt, manganese, gypsum, coal, copper, lead and zinc over the last two centuries. Today, potash is mined in the Sussex area.

The Hammond River completes its run from its source in the Caledonia Ecodistrict to the Kennebecasis River near Hampton. *Photograph © Ron Garnett–AirScapes.ca.*

5.11 Kingston Ecodistrict at a Glance

Ecoregion: Valley Lowlands

Area: 182, 294 ha

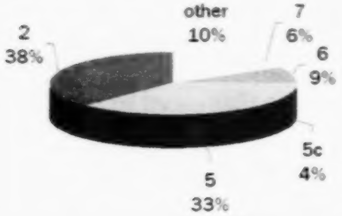
Average elevation above sea level: 74 m

Average May–September precipitation: 425–450 mm

Average annual degree-days above 5°C: 1600–1750

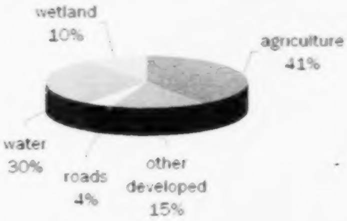
62% of Kingston Ecodistrict has forest cover

ecosite coverage of forest area



38% of Kingston Ecodistrict is not forested

uses of non-forest area



Ecosite map legend

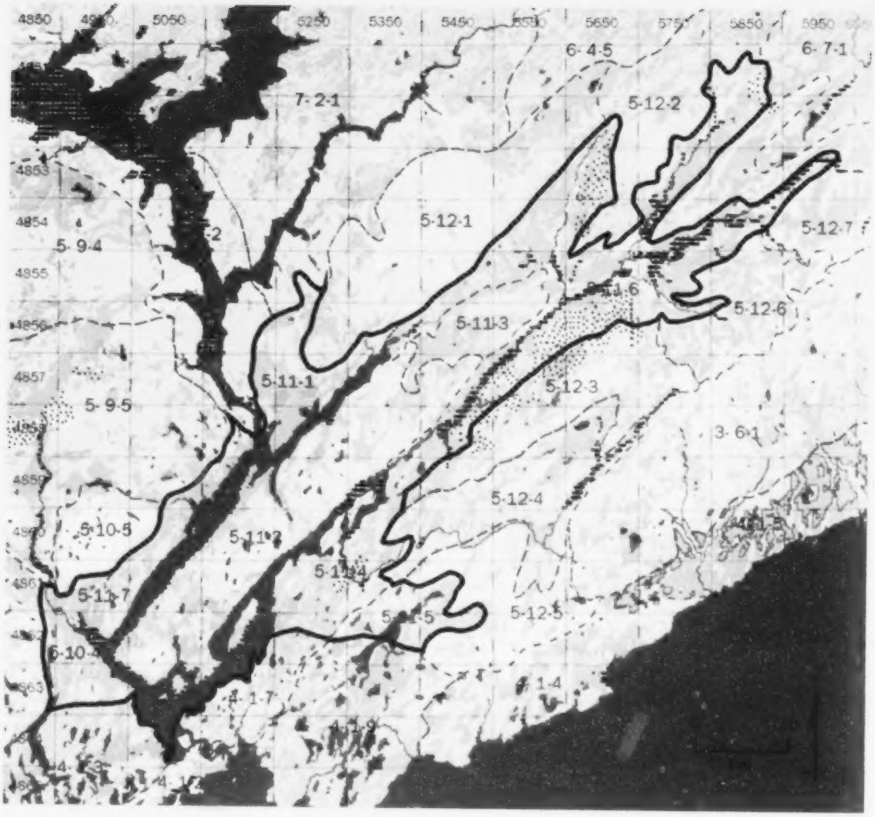
ecosite

- 1
- ▨ 2
- ▨ 3
- 4
- 5
- ▨ 6
- 7
- ▨ 8

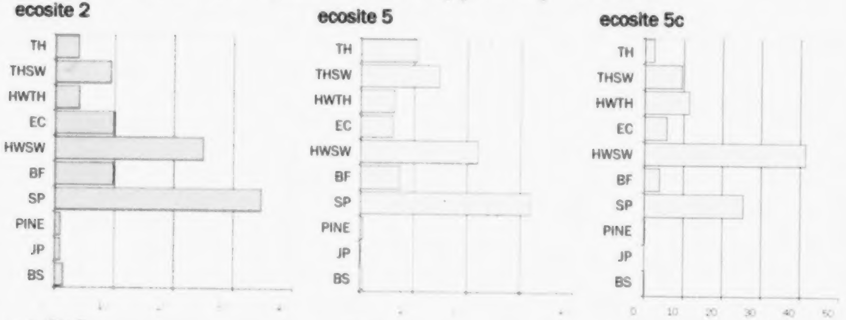
ecosite modifiers

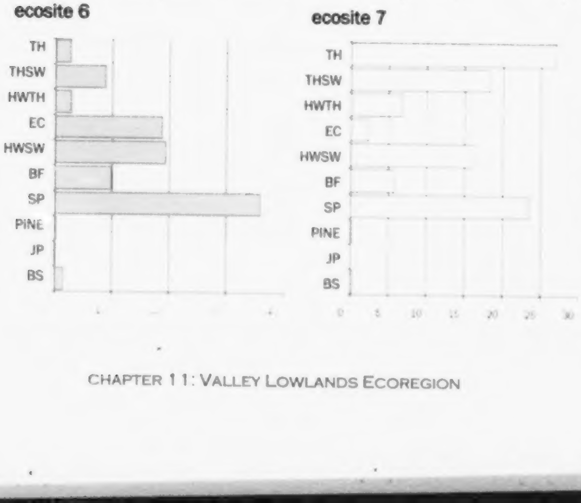
- ⁙ c (calcareous)
- ■ o (organic)
- ☰ f (periodically flooded)
- ☐ h (high elevation)
- ⁙ m (mining debris)

■ water


4850
4950
5050
5250
5350
5450
5550
5650
5750
5850
5950
4853
4854
4855
4856
4857
4858
4859
4860
4861
4862
4863
7-2-1
6-4-5
6-7-1
5-12-2
5-12-1
5-12-7
5-9-4
5-11-6
5-12-6
5-11-3
5-12-3
5-11-1
5-9-5
3-6-1
5-12-4
5-10-5
5-11-2
5-11-4
5-11-7
5-11-5
5-12-5
6-10-4
4-1-4
4-1-7
4-1-9
4-1-3
4-1-2

Percent cover of forest stand types by ecosite



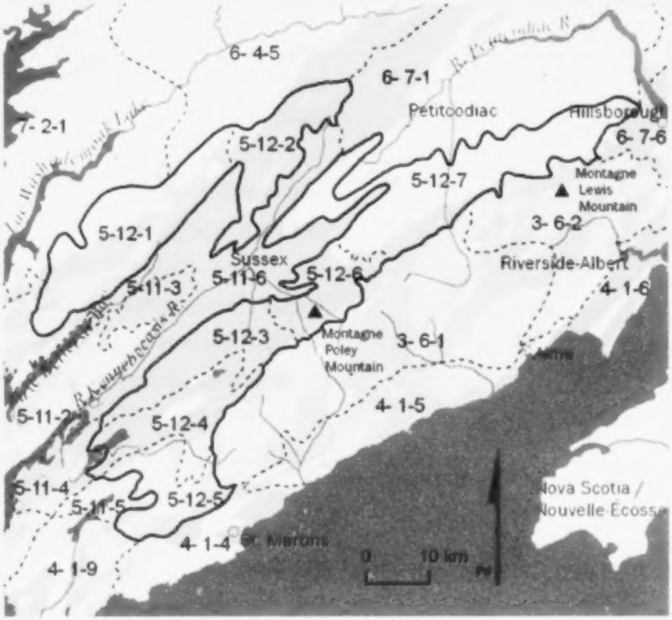


Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.

5.12. Anagance Ecodistrict

Anagance Ecodistrict is a rugged, bi-partitioned terrain in southern New Brunswick that borders the northern edge of the elevated Caledonia Ecodistrict and brackets the low-lying Kennebecasis Ecodistrict.

Geology


6- 4-5
6- 7-1
R. Petitcodiac R.
Petitcodiac
Hillsborough
6- 7-6
7- 2-1
5-12-2
5-12-7
Montagne Lewis Mountain
3- 6-2
5-12-1
Sussex
Riverside-Albert
5-11-3
5-11-6
5-12-6
4- 1-6
5-12-3
Montagne Poley Mountain
3- 6-1
R. Kennebecasis R.
5-11-2
5-12-4
4- 1-5
5-11-4
5-11-5
5-12-5
Nova Scotia / Nouvelle-Écosse
4- 1-4
St. Martins
0
10 km
N
4- 1-9

Geology of Anagance Ecodistrict

Rock Types

Highly calcareous sedimentary

Calcareous sedimentary

Non-calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites

The geology here presents a highly complex assemblage of lithologies. The predominant rocks are Pennsylvanian to Mississippian sedimentary strata containing red to grey conglomerate, sandstone, siltstone and shale with some evaporites including potash. These rocks are slightly calcareous to calcareous and, in some locations such as Hanford Brook, contain invertebrate fossils.

Two zones of older rocks also are present: one in the vicinity of Springdale in the north, and the other below Upham in the south. The northern zone comprises a mixture of Ordovician to Silurian sedimentary rocks interbedded with Cambrian to Silurian felsic and mafic volcanic rocks. The southern zone is underlain by Precambrian felsic to mafic volcanic rocks and granites that are among the oldest rocks in the province.

Three major northeast-trending faults intersect the bedrock and are part of a regional lineation that has influenced the direction of river drainage and topography throughout the ecodistrict.

Landscape and Climate

The ecodistrict's configuration consists of two elongated portions of land that include, and are separated by, Anagance Ridge. The upper portion lies north of Belleisle Bay and Kennebecasis River and reaches from Hatfield Point to Havelock. The lower portion is situated south of Kennebecasis River and stretches from Upham Mountain in the west to within a few kilometres of the Petitcodiac River in the east.

The landscape presents a dramatic contrast of steep, river-filled

Ecosite map legend

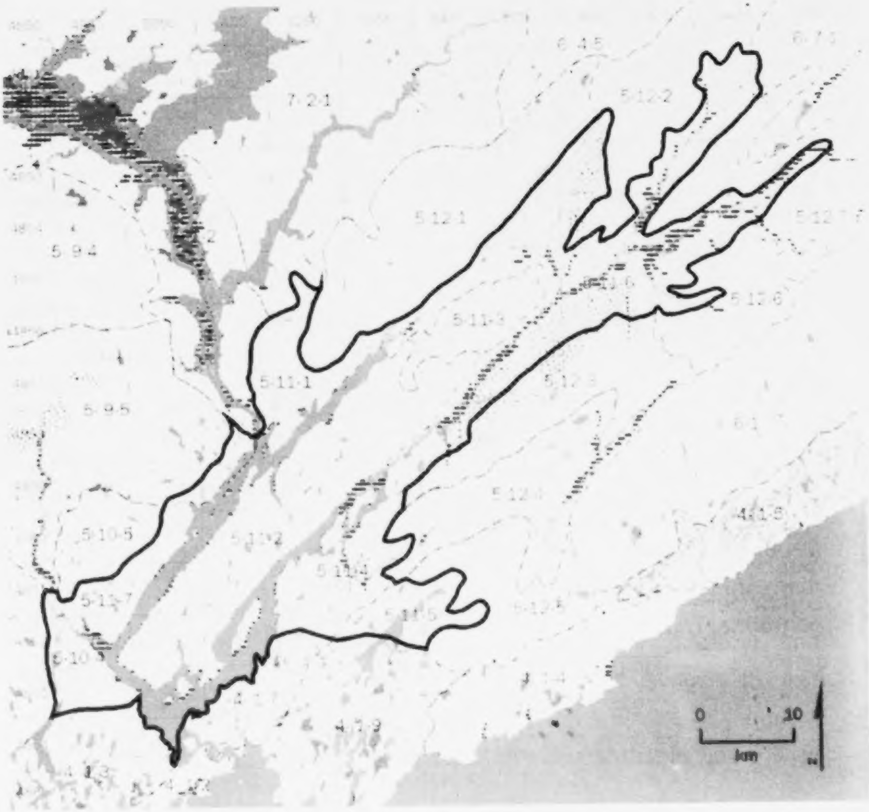
ecosite

1
2
3
4
5
6
7
8

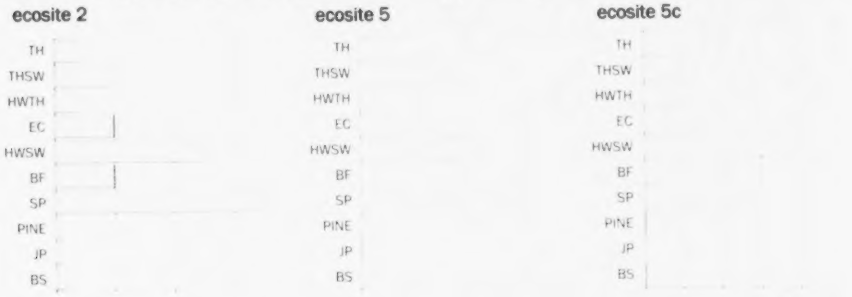
ecosite modifiers

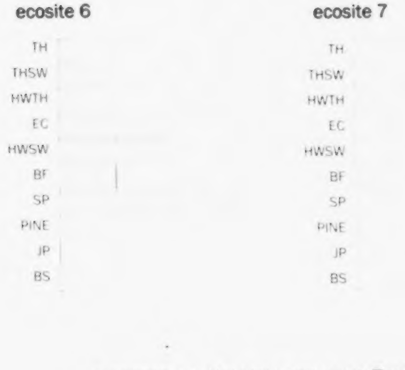
c (calcareous)
o (organic)
f (periodically flooded)
h (high elevation)
m (mining debris)

water


6-4-5
6-7-1
7-2-1
5-12-2
5-12-1
5-9-4
5-12-7
5-12-6
5-11-6
5-11-3
5-11-1
5-9-5
5-12-3
6-1
5-12-4
4-1-5
5-10-5
5-11-2
5-11-4
5-11-7
5-11-5
5-12-5
5-10-3
4-1-9
0
10
km

Percent cover of forest stand types by ecosite





Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce. **Horizontal axis**: percent cover.

5.12. Anagance Ecodistrict

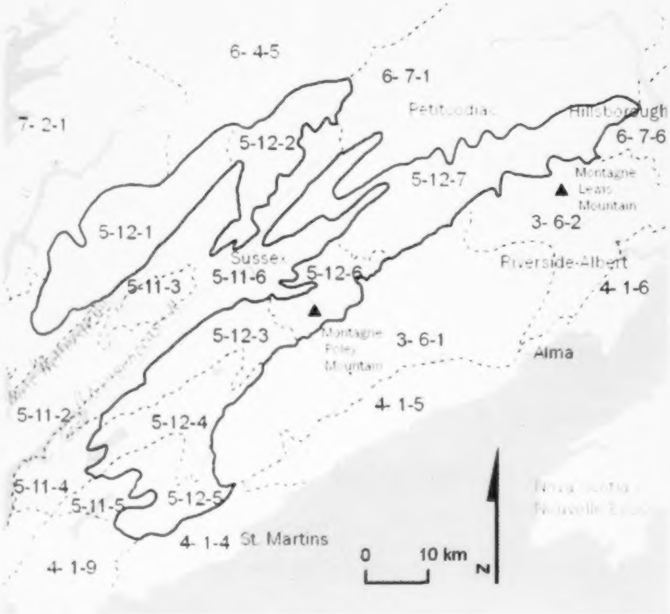
Anagance Ecodistrict is a rugged, bi-partitioned terrain in southern New Brunswick that borders the northern edge of the elevated Caledonia Ecodistrict and brackets the low-lying Kennebecasis Ecodistrict.

Geology

The geology here presents a highly complex assemblage of lithologies. The predominant rocks are Pennsylvanian to Mississippian sedimentary strata containing red to grey conglomerate, sandstone, siltstone and shale with some evaporites including potash. These rocks are slightly calcareous to calcareous and, in some locations such as Hanford Brook, contain invertebrate fossils.

Two zones of older rocks also are present: one in the vicinity of Springdale in the north, and the other below Upham in the south. The northern zone comprises a mixture of Ordovician to Silurian sedimentary rocks interbedded with Cambrian to Silurian felsic and mafic volcanic rocks. The southern zone is underlain by Precambrian felsic to mafic volcanic rocks and granites that are among the oldest rocks in the province.

Three major northeast-trending faults intersect the bedrock and are part of a regional lineation that has influenced the direction of river drainage and topography throughout the ecodistrict.


6- 4-5
6- 7-1
7- 2-1
Petitcodiac
Hillsborough
6- 7-6
5-12-2
5-12-7
Montagne Lewis Mountain
3- 6-2
5-12-1
Sussex
5-11-6
5-12-6
5-11-3
Riverside-Albert
4- 1-6
5-12-3
Montagne Poley Mountain
3- 6-1
Alma
4- 1-5
5-11-2
5-12-4
5-11-4
5-11-5
5-12-5
4- 1-4
St. Martins
4- 1-9
0
10 km
N
Nova Scotia
Nouvelle-Écosse

Geology of Anagance Ecodistrict

Rock Types

- Highly calcareous sedimentary
- Calcareous sedimentary
- Non-calcareous sedimentary
- Early Carboniferous sedimentary
- Late Carboniferous sedimentary
- Mafic volcanic
- Felsic volcanic
- Granites and granodiorites

Landscape and Climate

The ecodistrict's configuration consists of two elongated portions of land that include, and are separated by, Anagance Ridge. The upper portion lies north of Belleisle Bay and Kennebecasis River and reaches from Hatfield Point to Havelock. The lower portion is situated south of Kennebecasis River and stretches from Upham Mountain in the west to within a few kilometres of the Petitcodiac River in the east.

The landscape presents a dramatic contrast of steep, river-filled valleys curving around rugged hills and mountains, all of them trending northeasterly to mirror the underlying bedrock structure. A tributary of Parlee Brook is lined by amphitheatre gorges, one of which has a 75 m cliff face that is popular with rock climbers. Ridges typically rise 150 m with their crests reaching above 200 m; the maximum elevation of 320 m occurs in the vicinity of South Branch.

Several stories lie behind the naming of some topographic features in this area. Bull Moose Hill recalls a moose who broke his neck in a pasture near Hampton in the early 1800s. A small paper mill was established by M. Frances and Sons on Paper Mill Hill. Samp Hill, refers to samp, a porridge made of ground cornmeal and boiled maple sap.

Rivers in the northern section flow either northward into the Washademoak watershed or south into the Belleisle-Kennebecasis watershed. Rivers in the south flow uniformly north or northwest into the Kennebecasis or Petitcodiac rivers. The rugged terrain has a noticeable absence of lakes, except for Cassidy Lake northeast of Upham.

The predominance of Mississippian bedrock has given rise to a number of solution caves formed by underground streams dissolving the limestone strata.

The ecodistrict has a dry and warm climate, and is protected from southwesterly storms by the high elevation Caledonia Ecodistrict.

Soils

The more calcareous sedimentary rocks yield deep horizons of fertile loam to sandy loam belonging to the Parleeville-Tobique and Parry units. These compact tills support sugar maple and yellow birch on the hillsides. Pine and spruce tend to favour sites with more sandy or gravelly soils, such as those formed where the bedrock is highly conglomeratic.

The less calcareous sedimentary rocks have produced a variety of soils. Loose stony tills of the Sunbury and Reece units occupy the hills and valleys east of Springdale. They are derived from siliceous grey sandstone, and support jack pine, beech, and intolerant hardwood stands. Soils associated with reddish sandstone occur in the north and belong to the Stony Brook and Harcourt units.

The metasedimentary and volcanic rocks have produced shallow, less fertile soils of the Serpentine and Britt Brook units, and are concentrated in the vicinities of Hatfield Point and Upham.

Biota

Tolerant hardwood stands composed of beech, sugar maple, and yellow birch with minor white ash and ironwood occur on upper slopes and ridgetops covered by fertile soils (4,7, 8,). On less fertile soils, beech, red maple, and aspen often predominate.

A typical hardwood community of this type covers the escarpment north of Waterford with a ridgetop sugar maple, ash and beech community grading downslope into red oak and ironwood. The base of the escarpment holds an unusual grove of pure ironwood growing on fine talus material.

Softwood forests tend to be associated with lower slopes and shallow soils on hillsides (2). They are composed of red spruce, balsam fir, and white spruce with occasional hemlock and white pine. A mixed forest of hemlock and red spruce with mature sugar maple and beech occurs along Parlee Brook, where one of the hemlock stands protects a population of large round-leaved orchid. Several stands of hemlock also sit atop Pisgah Mountain.

White pine, jack pine, and red pine often occur on sites with droughty coarse soil (1), suggesting that fire has had an historic impact upon the landscape. Cedar is found primarily on the wetter and more fertile soils (6).

Although bogs are uncommon due to the rugged relief and scarcity of broad plains, a few wetlands exist in the north where the land borders the flatter terrain of the Grand Lake and Castaway ecodistricts. Here, Marrtown and Millstream bogs form part of a larger marshy area south of Canaan River. A wetland near Waterford is home to the rare species northern adder's tongue.

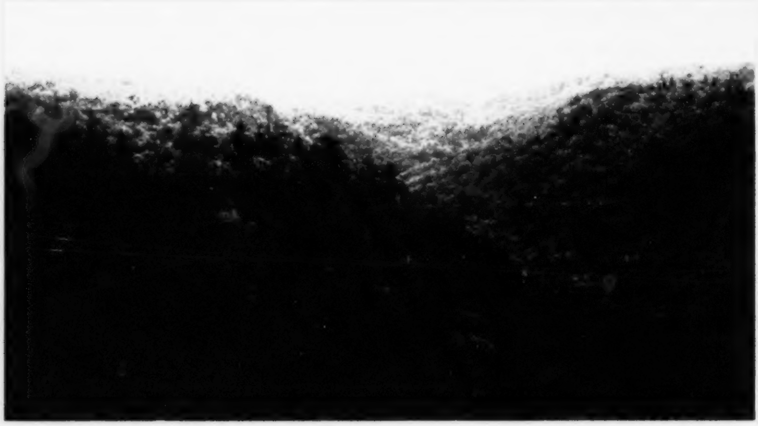
Solution caves are rare in New Brunswick but occur in this ecodistrict. One such cave is 115 m long, 3 m wide, with as stream flowing through its entire length. It is a winter hibernation site of the rare eastern pipistrelle bat. Even short visits to see them can harm their chances of survival, and they should be left undisturbed.

The calcareous bedrock near Havelock has given rise to a rich hardwood community on Butternut Ridge. Once resplendent with butternut trees, the ridge now guards less than half a dozen trees of this species, the remainder having been felled with the spread of agriculture in the area. Furniture created with Kings County butternut, especially butternut from this ridge, was famous among provincial craftsmen and today is prized by antique dealers across the Maritimes.

The elevated terrain overlooking Kennebecasis River valley has been heavily logged and now is dominated by an intolerant hardwood forest of red maple, trembling aspen, large-toothed aspen, white birch and grey birch. These early successional stands have a beech component on ridgetops such as Mount Pisgah, suggesting that a beech-dominated climax community potentially could develop on the sandy, nutrient-poor soils.

Settlement and Land Use

Anagance Ecodistrict straddles traditional Maliseet and Mi'kmaq territories, and has had an aboriginal presence for at least the last 2500 years. Native villages were located just outside the ecodistrict along the shores of the Kennebecasis and Washademoak waterways. Early reports show that the aboriginals made extensive use of the salt springs in the Anagance area. They also traversed the interior for the purposes of hunting and overland travel.



This red spruce mixedwood forest is near Parlee Brook.

The ecodistrict lay inland from the Kennebecasis River valley, which was one of the earliest sites in Canada populated by non-aboriginals. By the early 1800s, European and Loyalist inhabitants had expanded their settlements inland, lured by the relatively arable soil and inviting climate.

Logging began in the late 1700s and reached its pinnacle in the early 1800s, although timber volumes never approached anything like the tonnages removed from the Restigouche or Miramichi ecodistricts.

Many early villages were given names that revealed something of their local history and economy. Markhamville was named after Colonel Alfred Markham who operated manganese mine in the area. Salt was produced from salt springs near the villages of Salt Springs and Salina (salina is Latin for salty), and was used to flavour home-made butter.

The Penobsquis Sulphur Springs Company operated from the town of Springdale, presumably availing itself of a nearby sulphur spring. East Scotch Settlement was established in 1823 by people from Perth, Scotland. Various religious leanings also are evident in locations such as Goshen (the biblical land of milk and honey), Mount Pisgah (a mountain visited by Moses) and Damascus (as in the road to...).

Prospectors in the 1800s uncovered many economic minerals in this region: salt, potash, copper, gold, gypsum, zinc, manganese, and bog manganese. Some finds were simply explored, whereas others were mined sporadically.

The more recent mining operations include a silica quarry and a potash mine, both near Cassidy Lake. Workers at the silica quarry excavate a quartz-rich, unconsolidated sand and gravel deposit, and process the silica locally. The potash mine was situated south of Cassidy Lake and produced ore between 1985 and its closure in 1997 due to severe underground flooding.

Red oak and white pine are common species on ridges in the Anagance Ecodistrict.

The limestone deposits surrounding Havelock have been quarried since at least the early 1800s. They currently support a major regional industry producing material for the aggregate, agricultural, and chemical markets.

5.12 Anagance Ecodistrict at a Glance

Ecoregion: Valley Lowlands
Area: 164, 814 ha
Average elevation above sea level: 124 m
Average May-September precipitation: 425–450 mm
Average annual degree-days above 5°C: > 1700

Ecosite map legend

ecosite

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

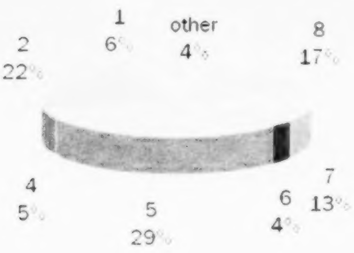
ecosite modifiers

- c (calcareous)
- o (organic)
- f (periodically flooded)
- h (high elevation)
- m (mining debris)

water

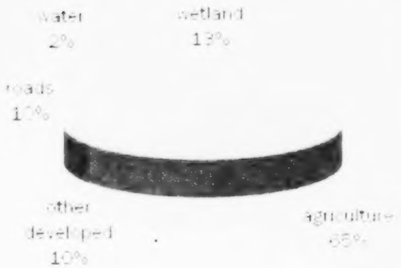
88% of Anagance Ecodistrict has forest cover

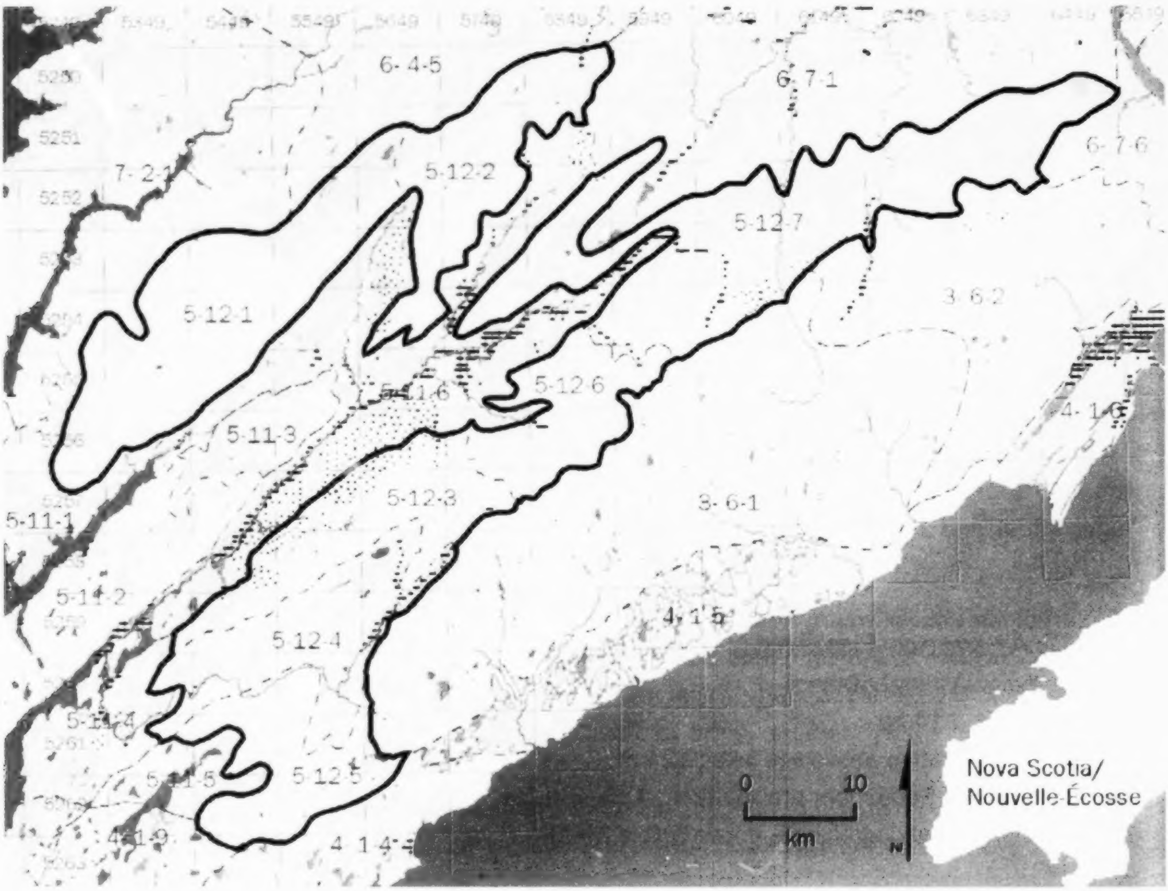
ecosite coverage of forest area



12% of Anagance Ecodistrict is not forested

uses of non-forest area




6-4-5
6-7-1
5250
5251
7-2-1
5252
5-12-2
6-7-6
5-12-7
5-12-1
3-6-2
5-12-6
5-11-6
4-1-6
5-11-3
5-12-3
3-6-1
5-11-1
5-11-2
4-1-5
5-12-4
5-11-4
5-11-5
5-12-5
4-1-9
4-1-4
0
10
km
N
Nova Scotia/
Nouvelle-Écosse

Ecosite map legend

ecosite

- 1
- ▨ 2
- ▨ 3
- 4
- 5
- ▨ 6
- 7
- ▨ 8

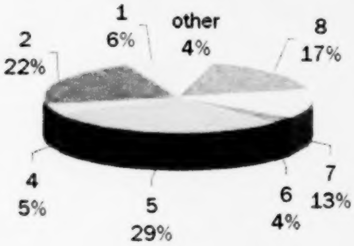
ecosite modifiers

- ⁘ c (calcareous)
- ■ o (organic)
- ☰ f (periodically flooded)
- ☐ h (high elevation)
- ⁘ m (mining debris)

■ water

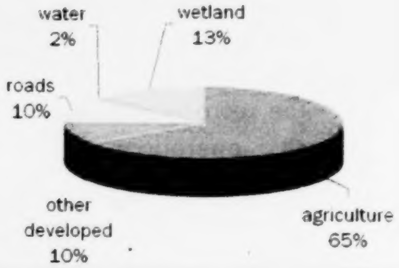
88% of Anagance Ecodistrict has forest cover

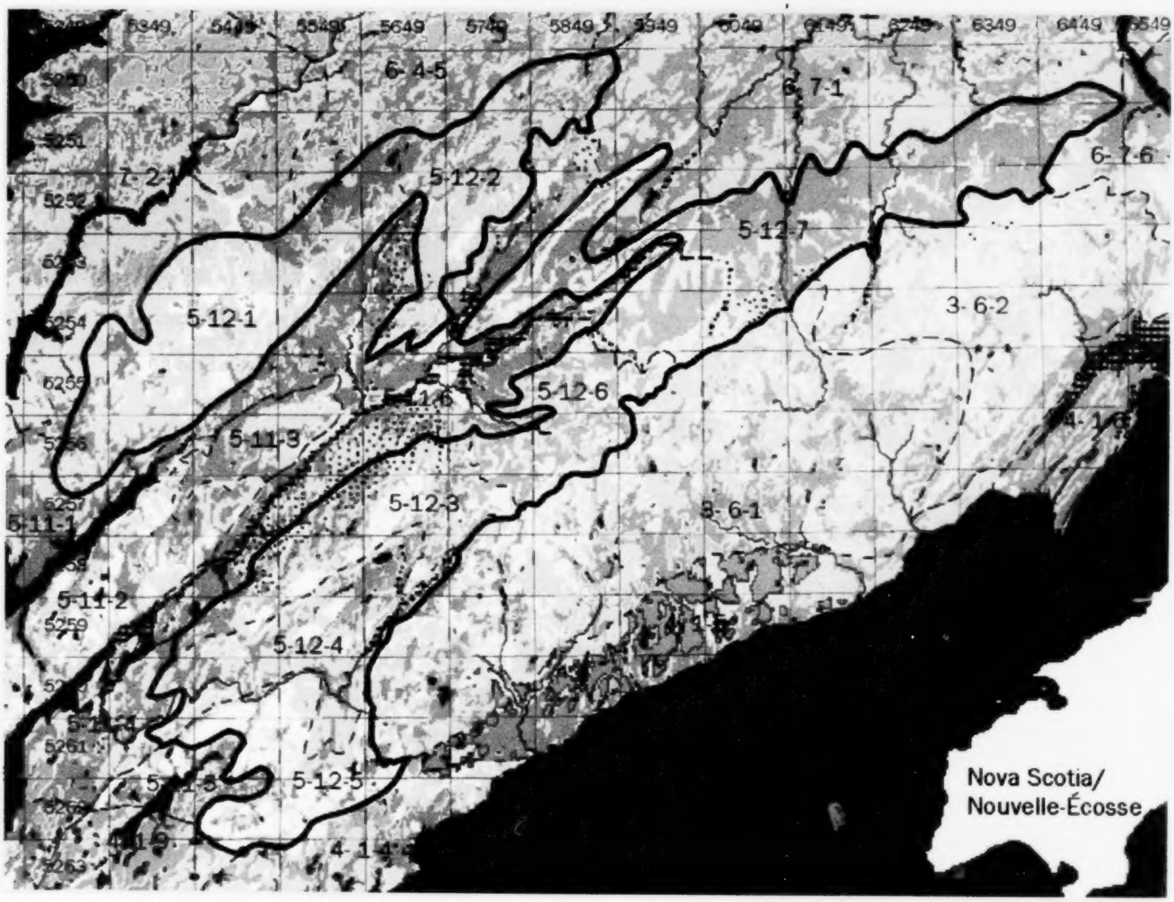
ecosite coverage of forest area



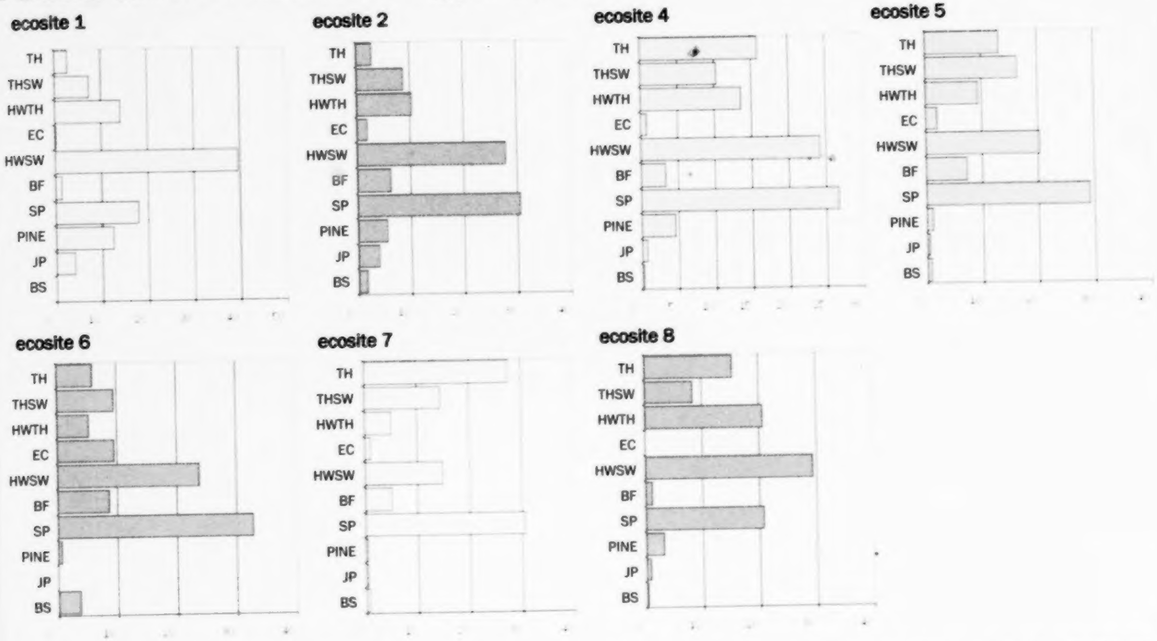
12% of Anagance Ecodistrict is not forested

uses of non-forest area

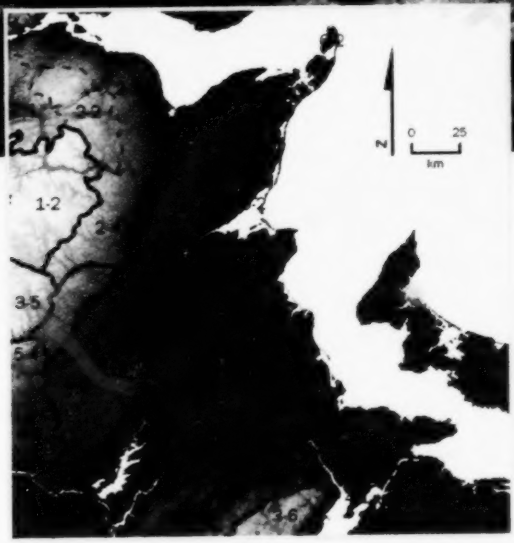



5349
5449
5549
5649
5749
5849
5949
6049
6149
6249
6349
6449
6549
5250
5251
5252
5253
5254
5255
5256
5257
5259
5261
5262
5263
6-4-5
6-7-1
7-2-1
5-12-2
6-7-6
5-12-7
5-12-1
3-6-2
5-12-6
5-11-6
5-11-3
5-12-3
5-11-1
8-6-1
5-11-2
5-12-4
5-12-5
4-1
Nova Scotia/
Nouvelle-Écosse

Percent cover of forest stand types by ecosite



Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.



The Eastern Lowlands Ecoregion includes the lower reaches of the Miramichi watershed, as well as the headwaters of several rivers that flow into the Northumberland Strait. Vegetation is dominated by acid-loving forests, heath species, and coastal zone specialists.

Chapter 12

6. Eastern Lowlands Ecoregion

The Eastern Lowlands Ecoregion is a broad wedge of flat to gently rolling terrain that reaches from Bathurst in the northeast down to Sackville in the southeast of the province. The region's northern and eastern margins are defined by Chaleur Bay and the Northumberland Strait. The coastal area bears a delicate fringe of sand dunes, salt marshes, and lagoons that harbour a distinctive fauna and flora. Inland, there are extensive peatlands hosting both common and rare plant and animal species.

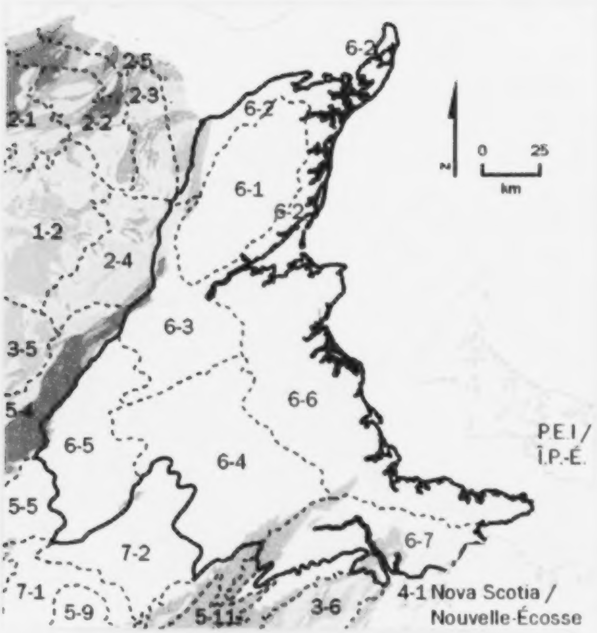
2-5
2-3
2-1
6-2
6-1
6
6-3
6-6
6-5
6-4
5-5
2
6-7
7-1
5-9
5-11
P.E.I /
Î.P.-E.
Nova Scotia /
Nouvelle-Écosse

The Eastern Lowlands Ecoregion includes the lower reaches of the Miramichi watershed, as well as the headwaters of several rivers that flow into the Northumberland Strait. Vegetation is dominated by acid-loving forests, heath species, and coastal zone specialists.

Chapter 12

6. Eastern Lowlands Ecoregion

The Eastern Lowlands Ecoregion is a broad wedge of flat to gently rolling terrain that reaches from Bathurst in the northeast down to Sackville in the southeast of the province. The region's northern and eastern margins are defined by Chaleur Bay and the Northumberland Strait. The coastal area bears a delicate fringe of sand dunes, salt marshes, and lagoons that harbour a distinctive fauna and flora. Inland, there are extensive peatlands hosting both common and rare plant and animal species.



Geology of Eastern Lowlands Ecoregion

Rock Types

Highly calcareous sedimentary
Calcareous sedimentary
Non-calcareous sedimentary
Early Carboniferous sedimentary
Late Carboniferous sedimentary
Mafic volcanic
Felsic volcanic
Granites and granodiorites

Geology and Landscape

The ecoregion is underlain by Carboniferous sedimentary rocks ranging from fine, reddish siltstones, through grey, quartz-rich sandstones, to coarse, pebble conglomerates. Elevations range between 150 m and sea level throughout the ecoregion.

The low relief of this ecoregion makes for poor soil drainage. In the north, the Nepisiguit River and a number of smaller streams and rivers flow towards Chaleur Bay or the eastern coast of the Acadian Peninsula. The Miramichi River and its countless sister rivers and streams drain the central part of the region, and an enormous volume of water enters Miramichi Bay beneath the bridges at Miramichi City. The Miramichi River between the town of Quarryville and Miramichi Bay is actually an estuary with a significant influence of ocean tides.

The Canaan and Salmon Rivers drain much of the boggy, central plateau areas of the ecoregion towards Grand Lake.

Along the southern Northumberland coast, several major rivers, including the Richibucto and Kougibouguac, move languidly eastward, typically merging into lagoons, tidal estuaries or salt marshes before reaching the Northumberland Strait. Rivers in the southeast corner of the region drain toward the Bay of Fundy, entering it either directly or via the Petitcodiac River.

Climate

The Eastern Lowlands Ecoregion lies at the intersection of two rain shadow areas. Most moisture from the prevailing westerly winds is intercepted by the Highlands Ecoregion to the west, whereas precipitation from southwesterly storms coming across the Bay of Fundy is intercepted by higher elevations of the Fundy Coast and Central Uplands ecoregions.

The upland areas to the south and west of the region offer protection, so that its inland summer temperatures are comparable to those in the Valley Lowlands Ecoregion. The Northumberland coastline experiences some of the highest summer temperatures in the province. Unlike the Bay of Fundy, the Northumberland Strait does little to moderate the summer climate, as the prevailing winds blow warm land air out to sea, rather than cool oceanic air onshore. In winter, waters from the strait tend to warm the adjacent land areas.

Forest Cover

The forests of this ecoregion display a primarily boreal-looking community of conifers that contrasts markedly with the more tolerant hardwood-dominated forests of the adjacent Valley Lowlands. Two reasons exist for this condition. First, the role of fire in forest composition is evident in the abundance of fire-adapted species such as trembling aspen, jack pine, red pine, white pine, and black spruce. Second, the low relief, poor soil drainage, and high soil acidity together create conditions that discourage the development of tolerant hardwood stands, which prefer well drained upper slopes and ridges.

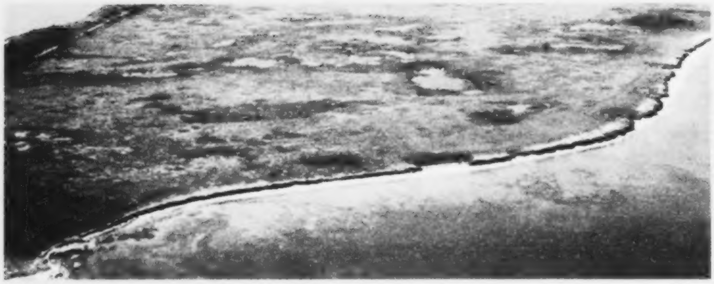
The Carboniferous strata of the region are very flat-lying and uniform; the only topographic relief results from rivers eroding the bedrock over long periods of time. The height of land between watersheds is dominated by expansive peatlands with only discontinuous, often stunted forest cover featuring black spruce, tamarack, and ericaceous shrubs. Sites with gently sloping terrain contain a distinctive association of red spruce, black spruce, balsam fir, red maple, hemlock, white pine, red pine, and jack pine. Only the relatively few hilltops in the region display the classic tolerant hardwood assemblage of sugar maple, yellow birch, and beech. The forest contains understorey species that typically occur with boreal-type forests and peatlands. These include sheep laurel, mountain-holly, speckled alder, wintergreen, goldthread, bunchberry, bristly club-moss, sphagnum, and Schreber's moss.

Wetlands

The Eastern Lowlands Ecoregion contains the highest percentage of wetlands of all New Brunswick ecoregions, and has by far the largest area of peatlands. The peatlands occur both inland and along the coast, and, in several locations, are being commercially 'mined' for horticultural peat. Most of the coastal peatlands are raised bogs with indicator species that include black crowberry and bake-apple, and are associated with an abundant cover of lichens. The bogs formed in shallow depressions following the post-glacial changes in sea levels and have since coalesced into extensive complexes. Unlike the raised bogs of the Fundy Coast

Ecoregion with their limited number of small surface pools, the Northumberland bogs have large surface pools.

The changing sea levels since glaciation have caused shorelines to shift back and forth for several millennia. In our current era of rising sea levels, some coastal bogs have been subject to wave erosion, exposing peat cliffs. These cross sections through peat reveal a chronicle of 10,000 years of post-glacial vegetation change.



Peat Cliffs near Pointe Escuminac; aerial view (above), and closeup.

The dramatic barrier beaches that characterize this ecoregion are the result of low coastal relief meeting the effects of longshore drift and other littoral phenomena. Interaction between the barrier beaches and the tidal estuaries at the mouths of major rivers has created a series of rich coastal marshes. Low marsh is a significant element in the complexes of the more southerly portion of the region along the Tormentine Peninsula (see Fundy Coast Ecoregion), while high marsh is generally more common, particularly in the shelter behind lagoons or barrier beaches. Alder shrub swamps occur alongside streams, while the few lakes tend to have peaty shorelines with a shrub cover of leather-leaf, rhodora, and Labrador-tea.

6.1. Tabusintac Ecodistrict

The Tabusintac Ecodistrict forms the oval-shaped core of the Acadian Peninsula in northeast New Brunswick. It sits at a higher elevation than the Caraquet Ecodistrict, which encircles it.

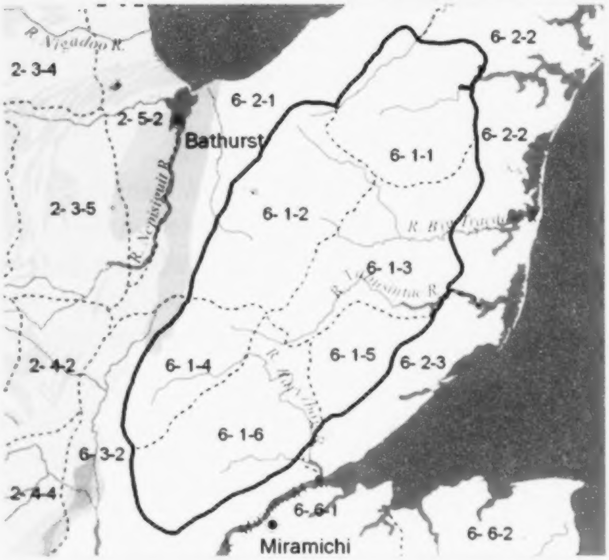
Geology

The entire ecodistrict is underlain by Pennsylvanian sedimentary rocks that consist of red, buff, grey and olive green sandstone, interbedded with mudstone and conglomerate.

A Jurassic diabase dyke called the Caraquet Dyke intersects the Tabusintac Ecodistrict at Petit-Pacquetville in the northeast and exits near Trout Brook in the southwest. This geological feature surfaces irregularly across much of the province.

Landscape and Climate

The Tabusintac Ecodistrict is encircled by coastal flats of the Caraquet Ecodistrict. The landscape undulates gently up from the



Geology of Tabusintac Ecodistrict

Rock Types

- Highly calcareous sedimentary
- Calcareous sedimentary
- Non-calcareous sedimentary
- Early Carboniferous sedimentary
- Late Carboniferous sedimentary
- Mafic volcanic
- Felsic volcanic
- Granites and granodiorites

bordering flatlands to a maximum height of about 180 m just south of Allardville, and then declines to 120 m at the western boundary.

Major rivers are the Caraquet, Pokemouche, Tracadie, Tabusintac, and Bartibog. They arise from interior bogs, lakes or springs, and flow eastward into saltwater bays of the Gulf of St. Lawrence. Although moderately incising in places, the rivers tend to meander across the land, gathering tributaries before merging into coastal estuaries teaming with a variety of plants and animals.

Lakes in the area are few, tiny, and shallow. Teagues Lake, south of Janeville is the largest and has extensive aquatic vegetation with one of the few yellow perch populations in northern New Brunswick. As would be expected in a region of slow-moving rivers and low relief, the landscape is a tapestry of richly hued bogs and marshlands.

The climate is dry and cool, as the land lies in the rain shadow of the Northern Uplands and Southern Upland ecoregions and is cooled by influences of the Gulf of St. Lawrence.

Soils

The widespread Pennsylvanian sedimentary rocks weather easily to form deep, acidic soils. Red mudstone in the south produces fine-textured, compact soils of the Stony Brook and Harcourt Units. The soils have low inherent fertility, but are well-textured and low in stoniness. Where situated on sites with good drainage, they support agricultural crops.

Olive grey sandstone in central parts of the ecodistrict yields compact, medium-textured loamy soils of the Reece Unit, and non-compact, coarse-textured soil of the Sunbury Unit. The latter soils occur close to Allardville and St-Isidore, and tend to line the incised river valleys. Shallow, residual soils of the Fair Isle Unit, also derived from olive grey sandstone, occur farther east between the Tracadie and Tabusintac Rivers.

A large glaciofluvial deposit belonging to the Riverbank Unit occurs along the upper stretches of the Pokemouche River. These droughty soils are among the least fertile in the area, and are tolerated mainly by jack pine and black spruce. Patches of poorly-drained Organic Unit soil are associated with headwaters of the Bartibog and Tabusintac Rivers.

Biota

A combination of high fire frequency and acidic, wet soils is reflected in the largely coniferous forest cover here. Black spruce dominates along upper stretches of the Bartibog River, where fine-textured, poorly drained soils (3) are common; it is accompanied by balsam fir, jack pine, and occasional white pine.

Large stands of jack pine frequent the sandier soils (1, 2) of the Tabusintac and Tracadie river valleys, whereas balsam fir, red spruce, hemlock, and white spruce, mixed with hardwoods, tend to occur on the mid-slope (5) sites.

Pure tolerant hardwood communities here are infrequent and grow only on the steeper slopes and ridgetops (4, 8). Deciduous forests more commonly tend to consist of trembling aspen, white birch, and red maple. However, the well drained slopes (7) east of Allardville support some mixed forests with red maple, beech, red spruce, and balsam fir.

Sugar maple occurs in scattered, but productive, patches around Pacquetville. One commercial sugar bush in the area supports a grove of trees that has individual specimens more than 200 years old. The community of Notre-Dame-des-Érables was named for its local maple stands.

The peat bogs, estuaries, and riverbanks make for an interesting assemblage of flora and fauna. Two species of orchids occur along the South Branch of the Little Bartibog River near Highway 8. The Tracadie River has several sites with unusual plants, such as bloodroot and little shinleaf.

Back Dam Marsh east of Patterson Siding attracts a wide diversity of ducks, plus great blue heron, belted kingfisher, and ruffed grouse. A bog just east of Bartibog Station is the largest minerotrophic peatland in northern New Brunswick. At Gaythorne, the Tabusintac estuary fingers inland from the coast to feed Big Marsh, which is a brackish intertidal haven for osprey, great blue heron, bald eagle, and waterfowl.

The Tabusintac Ecodistrict has attracted several uncommon butterfly species. The purple lesser fritillary and greenish blue can be sighted in the vicinities of Allardville and Bartibog. Summer visitors to the sandier stretches of Highway 8 around Bartibog might glimpse various species of elfin butterflies or, if they are lucky, the scarce silvery checkerspot.

Large numbers of great spangled fritillary occur along the lower reaches of the Tracadie River, and brighten up the now-inactive Tracadie Military Area.

Settlement and Land Use

The Tabusintac Ecodistrict lies within the traditional Mi'kmaq territory of Gespegeog. Aboriginals from coastal communities that lay just beyond the eastern ecodistrict border at the mouths of the Tabusintac, Tracadie, and Pokemouche Rivers visited the area regularly for fishing and hunting.

The first non-aboriginal residents on the Acadian Peninsula were early French and refugee Acadian settlers who chose to live along the coast. Not until the *Free Grants Act* in the 1860s did inland villages, such as St-Isidore and Pacquetville, begin to appear within the ecodistrict. The gentle terrain enabled settlements to expand out from the coast and rivers over time.

The completion of the Intercolonial Railway between Bathurst and Newcastle in 1876 caused new hamlets to spring up along the railroad, one of which was Bartibog Station. A wartime train carrying Sir Winston Churchill to Québec City was sidetracked overnight at Bartibog Station to give Churchill an undisturbed sleep.

Records show that logging began modestly in the early 1800s and continued more or less steadily over the next century. The area's type of forest cover, boggy terrain, and fire frequency prevented it from achieving anything like the phenomenal productivity of the Miramichi and Restigouche tracts during their logging heyday.

Few economic mineral deposits of interest have been discovered here. Buff sandstone outcrops were quarried in the past for dimension stone to erect local buildings such as the St-Augustine Church in Paquetville and St-Isidore Church in St-Isidore. The latter church, in particular, is an opulent delight with its pure white interior and 14-carat gold leaf appliqué along ceilings, pillars, and walls.

St-Augustine Church in Paquetville, New Brunswick.

6.1. Tabusintac Ecodistrict at a Glance

Ecoregion: Eastern Lowlands

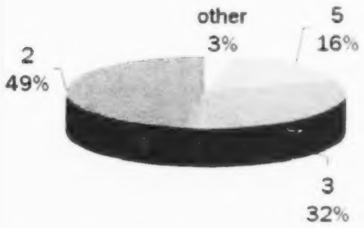
Area: 255, 996 ha

Average elevation above sea level: 98 m

Average May-September precipitation: 375 mm

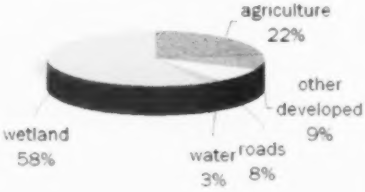
Average annual degree-days above 5°C: 1,400–1,600

90% of Tabusintac Ecodistrict has forest cover

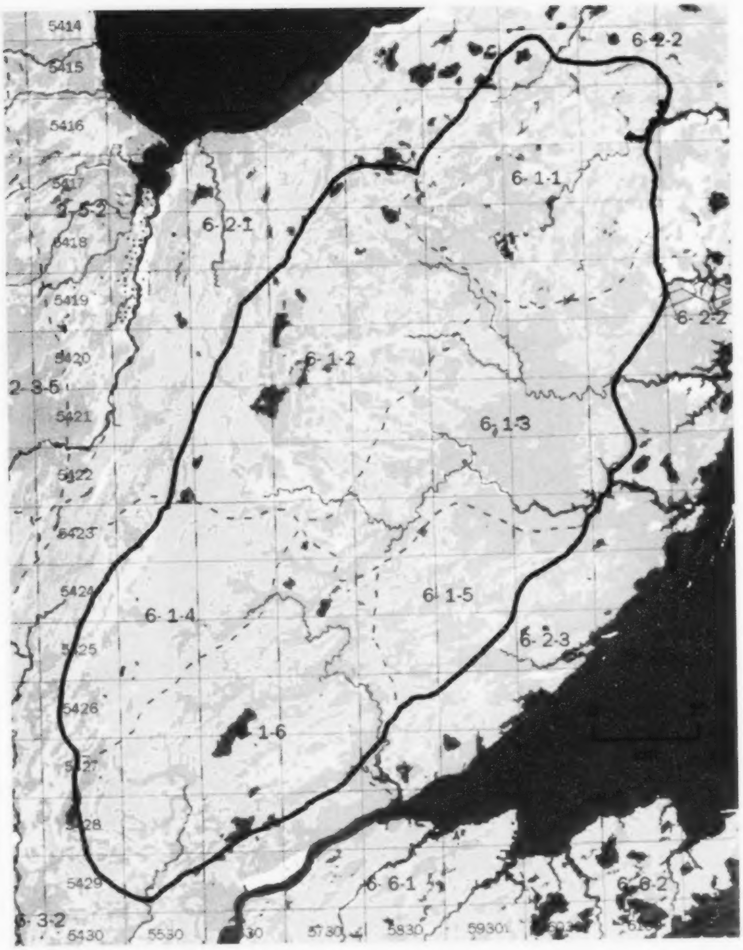


ecosite coverage of forest area

10% of Tabusintac Ecodistrict is not forested



uses of non-forest area


5414
5415
5416
5417
2-5-2
5418
5419
5420
2-3-5
5421
5422
5423
5424
5425
5426
5427
5428
5429
6-3-2
5430
5530
5730
5830
5930
6-2-2
6-1-1
6-2-1
6-2-2
6-1-2
6-1-3
6-1-4
6-1-5
6-2-3
1-6
6-6-1
6-6-2

Ecosite map legend

ecosite

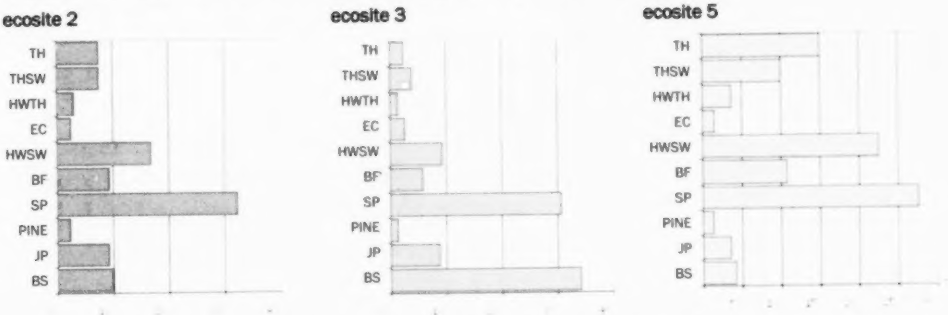
- 1
- ▨ 2
- ▨ 3
- ▨ 4
- ▨ 5
- ▨ 6
- 7
- ▨ 8

ecosite modifiers

- ▨ c (calcareous)
- ■ o (organic)
- ▤ f (periodically flooded)
- ☐ h (high elevation)
- ▨ m (mining debris)

■ water

Percent cover of forest stand types by ecosite



Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.

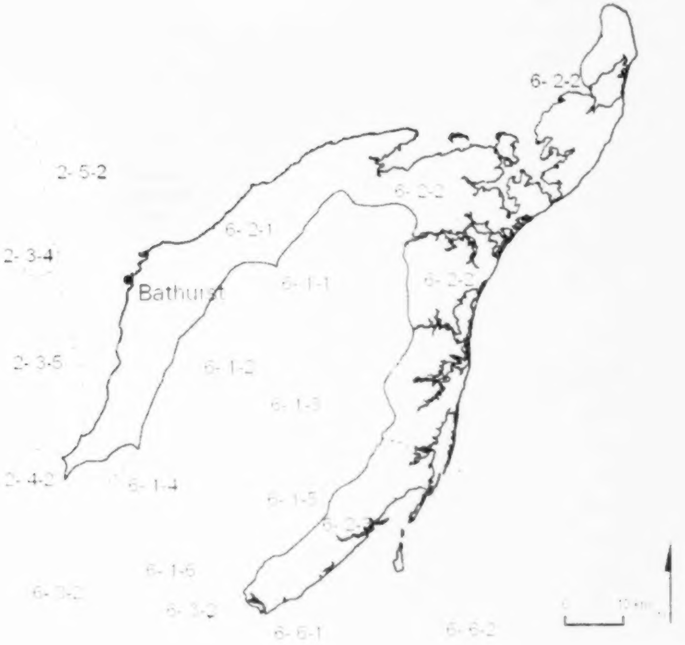
6.2. Caraquet Ecodistrict

The Caraquet Ecodistrict is a crescent of land averaging 10 km wide that rims the Acadian Peninsula coastline. It begins at the mouth of the Nepisiguit River, curves around Miscou Island, and ends at the mouth of the Miramichi River.

Geology

The bedrock in this ecodistrict consists almost entirely of Pennsylvanian non-calcareous red and grey sandstone, interbedded with mudstone and conglomerate. The sea stacks at Pokeshaw Provincial Park display several of these rocks in sequence, with grey sandstone at the base overlain by red conglomerate and sandstone. A thin band of red, slightly calcareous Pennsylvanian conglomerate and sandstone occurs along the Nepisiguit River.

Pennsylvanian plant fossils are visible in several locations, including the sandstone cliffs at Stonehaven and Clifton, where they are associated with coal seams. Plant fossils at Pigeon Hill, near Lamèque, are partly replaced and encrusted by two copper minerals: bright green malachite and blue connellite.



Geology of Caraquet Ecodistrict

Rock Types

Highly calcareous sedimentary

Calcareous sedimentary

Non calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites

Landscape and Climate

The landscape here can be divided into three distinct zones. The smallest zone parallels the western border and the Nepisiguit River, stretching from near Bathurst Mines up to the town of Bathurst. The land achieves an elevation of perhaps 100 m, and its streams and rivers drain into the Nepisiguit River.

The second zone is situated between Bathurst and Caraquet Island. It has a low, gently sloping appearance with coastal cliffs measuring perhaps 30 m high near Grand Anse. Its rivers flow towards Chaleur Bay, and the beaches feature crumbling sandstone cliffs with an unfettered view over much of the bay.

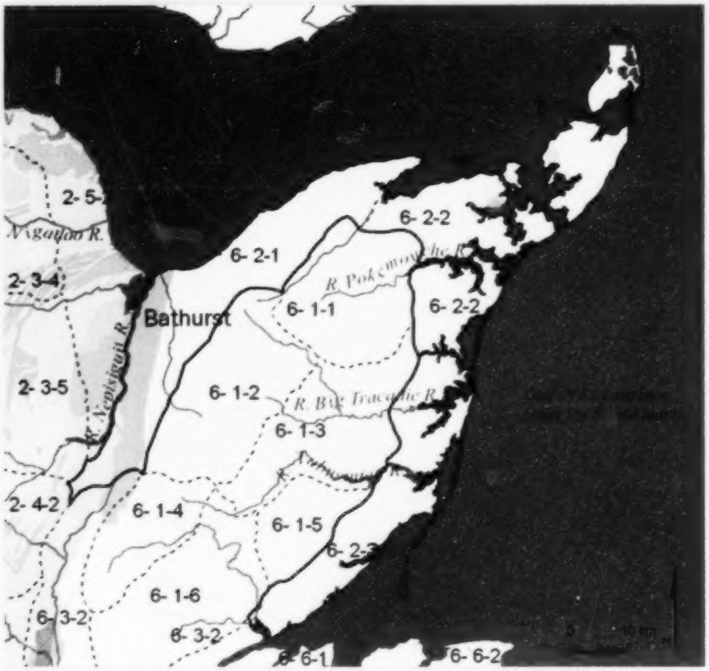
6.2. Caraquet Ecodistrict

The Caraquet Ecodistrict is a crescent of land averaging 10 km wide that rims the Acadian Peninsula coastline. It begins at the mouth of the Nepisiguit River, curves around Miscou Island, and ends at the mouth of the Miramichi River.

Geology

The bedrock in this ecodistrict consists almost entirely of Pennsylvanian non-calcareous red and grey sandstone, interbedded with mudstone and conglomerate. The sea stacks at Pokeshaw Provincial Park display several of these rocks in sequence, with grey sandstone at the base overlain by red conglomerate and sandstone. A thin band of red, slightly calcareous Pennsylvanian conglomerate and sandstone occurs along the Nepisiguit River.

Pennsylvanian plant fossils are visible in several locations, including the sandstone cliffs at Stonehaven and Clifton, where they are associated with coal seams. Plant fossils at Pigeon Hill, near Lamèque, are partly replaced and encrusted by two copper minerals: bright green malachite and blue connellite.



Geology of Caraquet Ecodistrict

Rock Types

Highly calcareous sedimentary

Calcareous sedimentary

Non-calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites

Landscape and Climate

The landscape here can be divided into three distinct zones. The smallest zone parallels the western border and the Nepisiguit River, stretching from near Bathurst Mines up to the town of Bathurst. The land achieves an elevation of perhaps 100 m, and its streams and rivers drain into the Nepisiguit River.

The second zone is situated between Bathurst and Caraquet Island. It has a low, gently sloping appearance with coastal cliffs measuring perhaps 30 m high near Grand Anse. Its rivers flow towards Chaleur Bay, and the beaches feature crumbling sandstone cliffs with an unfettered view over much of the bay.

The third, and largest, landscape zone reaches from Caraquet Island around the Miscou Lighthouse and down to Bartibog Bridge. The coastline in this area is linked by an almost continuous chain of sand dunes, sand spits, protected bays, and salt marshes, severed only by estuaries of the Pokemouche, Tracadie, Tabusintac, and other rivers merging into the Gulf of St. Lawrence.

The cool, dry climate of the Caraquet Ecodistrict resembles that in the adjacent Tabusintac Ecodistrict, but its summer wind velocity is nearly twice the speed of the inland breezes. Prolonged exposure to the buffeting onshore winds has stunted and damaged many coastal trees, an effect which gradually diminishes inland.

Tabusintac Gully. *Photograph © Ron Garnett–AirScapes.ca.*

Soils

The Pennsylvanian rocks have produced relatively fertile soils, due in part to the lithological variety in the conglomerates. The ecodistrict border approximates the boundaries of soils derived from marine or glaciomarine sediments. These range from the fine textured soils of the Tracadie Unit, derived from red mudstone, to the coarse textured soils of the Riverbank Unit, associated with grey sandstone.

Glaciomarine soil of the Barrieau-Buctouche unit is intermediate in composition between the Tracadie and Riverbank Units. It displays sandy, non-compact material over a reddish, loamy compact till and is suitable for agriculture if well drained.

Glacial tills occur farther inland where fine-textured, compact soils of the Stony Brook Unit are the most common. Medium-textured, compact soils derived from red conglomerate and belonging to the Parry Unit are limited to areas near Meadow Brook.

Organic soils have developed in many of the flat, poorly drained coastal areas and include large peat bogs near Shippagan, Caraquet, Grande-Anse and Wishart Point.

Biota

The long history of settlement and forest disturbance has resulted in a dominant forest of intolerant hardwood species: red maple, trembling aspen, and grey birch. Traces of sugar maple, yellow birch, and beech occur only along the inland perimeter.

Valley bottoms (2) and sites with coarse-textured soils (1) are covered with species such as black spruce and jack pine, which indicate a high fire frequency. The mid-slopes tend to support more hardwood, especially red maple, together with red spruce, white pine, balsam fir, and hemlock.

Hemlock used to be more widespread on the Acadian Peninsula, but is now reduced to remnant stands. Eastern white cedar and tamarack commonly occur with black spruce in areas of poor drainage (3, 6).

The predominantly coastal, sand dune environment has given rise to salt marshes, dunes, beaches and spits that offer refuge to several species of rare or endangered plants, birds and butterflies.

One of the more outstanding sites is Miscou Island's northeast shoreline, which has the widest dune system in eastern Canada. It displays a range of ecological succession with shoreline grasses grading into areas with wild iris and sweet gale, through to inland areas where stunted white spruce anchors the soil against ceaseless winds.

Miscou Island is also host to the Gulf of St. Lawrence Aster, one of two rare annual asters that are shared between Caraquet and the Tabusintac Ecodistrict. As the name implies, the Gulf of St. Lawrence Aster is known only from the shores of the Gulf of St. Lawrence. The other aster, Annual Saltmarsh Aster, has a form that appears to be unique to the New Brunswick coast. While taxonomists no longer consider this to be a separate species, its distinctiveness has nonetheless earned it the name of Bathurst Aster - reminiscent of the area from which it was first described.

As the Caraquet Ecodistrict extends into the Gulf of St. Lawrence, in the form of Lameque and Miscou islands, it intercepts the path of many migratory bird species. The large numbers of birds moving through the area include the occasional confused individual that has traveled off course and finds itself outside its normal geographic range. Miscou Island, in particular, has hosted several unexpected visitors, such as the fork-tailed flycatcher and the scissor-tailed flycatcher.

Rare birds seen here include the endangered piping plover, which nests in this and the adjacent Kouchibouguac Ecodistrict. It is recognized as nationally endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and is protected under the provincial *Endangered Species Act*. Tabusintac Gully is an important breeding ground for piping plover, terns, and other shorebirds. The largest black-crowned night heron colony in the Maritimes occurs farther south near Inkerman, at a site that also harbours great blue heron.

The salt marshes of the ecodistrict host several interesting butterfly species, including the nationally and provincially rare Maritime ringlet. These marshes also harbour the salt-marsh copper, and the uncommon short-tailed swallowtail butterflies.

Settlement and Land Use

The Caraquet Ecodistrict lies within the traditional Mi'kmaq territory of Gespegeog and has many archaeological sites. For at least 4000 years, the Mi'kmaq or their ancestors had settlements at the mouths of the Tabusintac, Tracadie, and Pokemouche Rivers where they fished the rivers, gathered shellfish, and hunted seabirds and sea mammals.

The French explorer and merchant Nicolas Denys established a short-lived fishing and fur trading post on Miscou Island in 1645. About eighty years later, French immigrants formed a permanent settlement at Caraquet. They subsequently were joined by Acadians returning from exile in the 1760s and, later, by people from Québec. More recent native villages were situated at Miscou Island and farther south at Burnt Church, where the Recollects established a mission in 1685-86.

Pokemouche River, looking north. *Photograph © Ron Garnett--AirScapes.ca.*

The various communities that evolved along the coast relied upon fishing, farming, and logging for their livelihood. Between the late 1700s and about 1930, an important grindstone industry thrived on the north shore.

Extensive coastal quarries were worked at Stonehaven, New Bandon, Clifton, and Grande Anse. The stone was used to make grindstones for markets across eastern North America, and also to provide building stone for the area's many stone churches.

The local economy today depends heavily upon its natural resources, including the fisheries. Peat harvesting takes place at nearly two dozen coastal bogs.

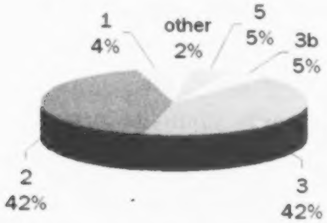
Mixed farming occurs patchily along the coast and is dominated by pasture, forage, and grain production, with significant areas of blueberry harvesting.

Burnt Church First Nation occupies Burnt Church Point in the foreground. Beyond Morin Point and Hay Island lies the village of Neguac.

6.2. Caraquet Ecodistrict at a Glance

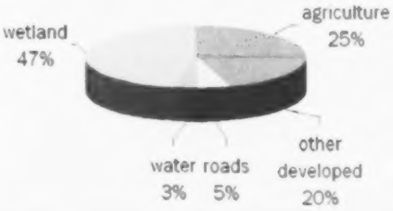
Ecoregion: Eastern Lowlands
Area: 200, 166 ha
Average elevation above sea level: 42 m
Average May–September precipitation: 350–400 mm
Average annual degree-days above 5°C: 1400–1600

70% of Caraquet Ecodistrict has forest cover

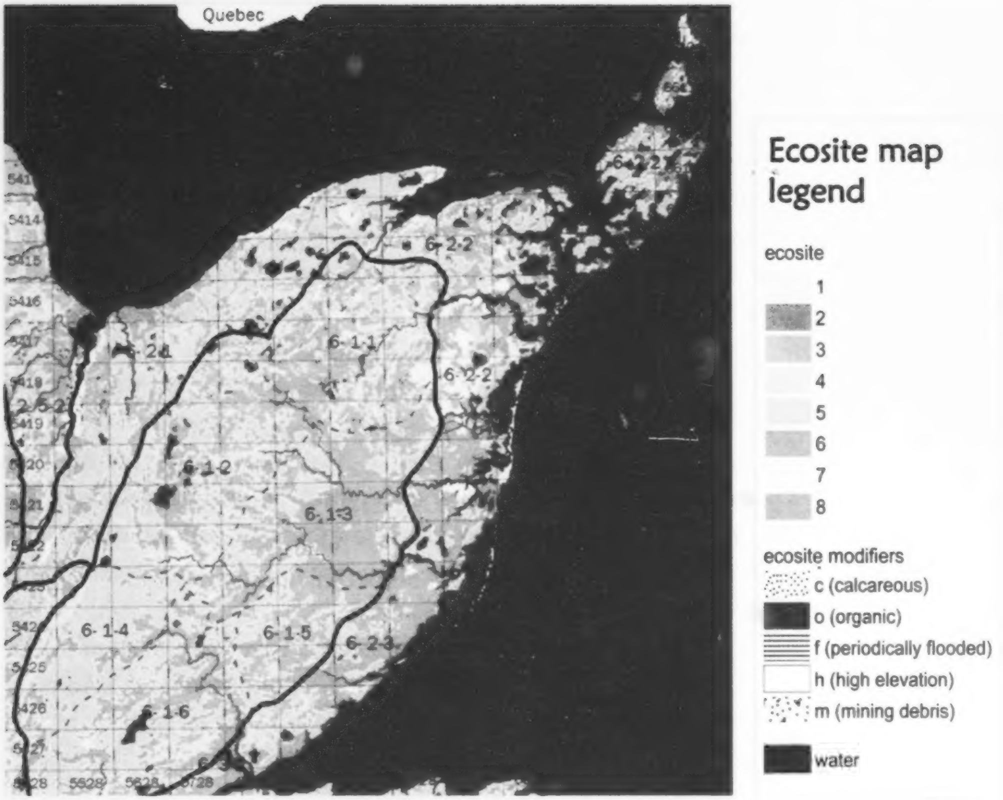


ecosite coverage of forest area

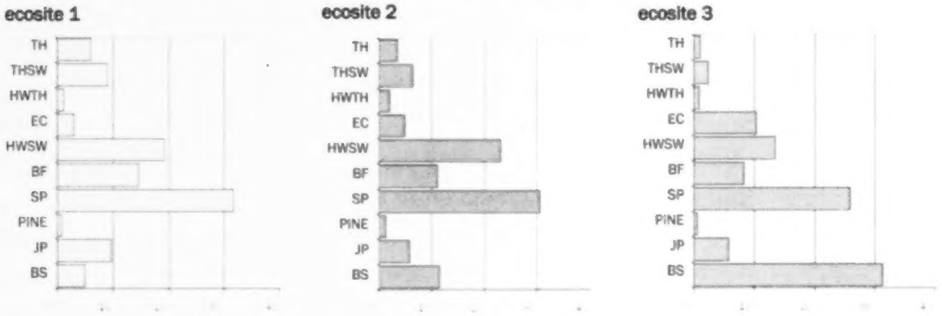
30% of Caraquet Ecodistrict is not forested

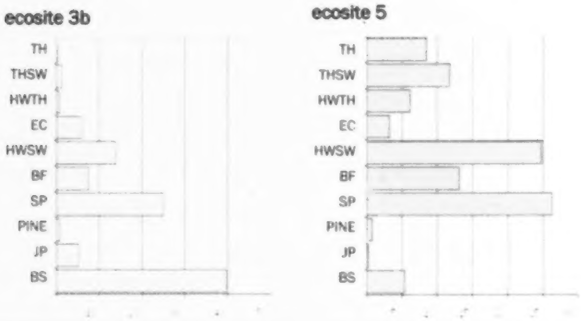


uses of non-forest area


Quebec
6-2-1
6-2-2
6-1-1
6-2-2
6-1-2
6-1-3
6-1-4
6-1-5
6-2-3
6-1-6
Ecosite map legend
ecosite
1
2
3
4
5
6
7
8
ecosite modifiers
c (calcareous)
o (organic)
f (periodically flooded)
h (high elevation)
m (mining debris)
water

Percent cover of forest stand types by ecosite





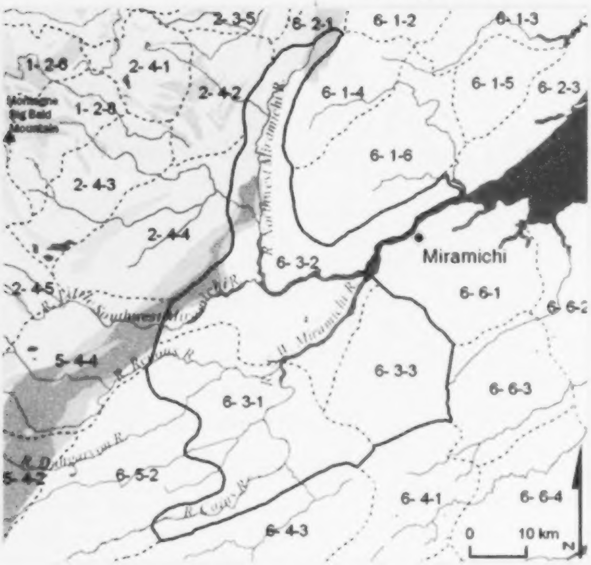
Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis:** percent cover.

6.3. Red Bank Ecodistrict

The Red Bank Ecodistrict presents a flat to gently sloping terrain that includes the lower reaches of the Southwest and Northwest Miramichi rivers.

Geology

The bedrock consists primarily of the same Pennsylvanian lithologies—red, buff and grey sandstone, mudstone, and conglomerate—that underlie much of the Eastern Lowlands Ecoregion.



Geology of Red Bank Ecodistrict

Rock Types

Highly calcareous sedimentary

▨ Calcareous sedimentary

Non-calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites

A narrow zone of older rock outcrop in the western part of the ecodistrict. These are mainly Ordovician metasedimentary rocks, dominated by metaquartzite, phyllite and slate, interbedded with some Silurian sedimentary rocks and Ordovician mafic volcanic rocks.

An unusual cave is located near Oldfields Island on the Northwest Miramichi River. Its entrance is 20 m wide, 5 m tall, and embedded with angular pebbles of rose and milky quartz.

Landscape and Climate

The Red Bank Ecodistrict is the geographic point of reckoning for all tributaries, branches, and streams associated with the Miramichi River. The Northwest Branch, Little Southwest Miramichi, Southwest Miramichi, Renous and Dungarvon Rivers converge within the ecodistrict, surging their joint waters under the Centennial Bridge at Miramichi City to enter Miramichi Bay.

The size and power of the rivers has enabled them to erode and dissect the landscape fairly deeply. River valleys drop about 70 m from riverbank to riverbed, and even more along the east shore of the Northwest Miramichi River.

The climate is relatively warm and dry. Summer precipitation is substantially lower than in adjacent ecodistricts to the west, with an associated greater risk of forest fire. The area has a high historical incidence of fires, the most famous being the 1825 Miramichi Fires.

The highest elevation in this otherwise low-lying terrain is 152 m near the village of Lumsden Road.

Soils

Soils are poorly drained because of low relief and tend to have limited fertility regardless of bedrock derivation.

Large deposits of glaciofluvial, alluvial, and marine materials line the major rivers. Sand and gravel are the dominant constituents, forming coarse-textured, generally droughty soils of the Gagetown and Riverbank Units. They are ideally suited for pines and black spruce.

Soils located inland away from the river valleys are mainly grey, compact basal tills belonging to the Reece and Rogersville Units. The Reece Unit derives from grey sandstone, while the Rogersville is quite similar to the Reece, but with a minor metasedimentary and igneous rock component. Red compact soils of the Stony Brook Unit occur in small areas north of Sunny Corner. Their fine texture gives these soils a high nutrient-holding capacity which is sometimes realized where slopes are well drained.

Biota

Forests here are dominated by black spruce and red spruce, often in association with balsam fir and hemlock, or, less commonly, jack pine and white pine.

Black spruce is most common on wet flatlands (3, 3b) and is found together with cedar on wet seepage slopes (6). Red spruce becomes more dominant on moist flatlands and slopes (2, 5), whereas pine is prominent on the dry, flat areas (1) along the major tributaries of the Miramichi River. Impressive specimens of both species can be seen in places near Doaktown, where white pine and red spruce tower over a mixture of balsam fir, red maple, and beech.

A site south of Red Bank has a large, mature coniferous community of red spruce with hemlock. Its understorey of dwarf rattlesnake-plantain and painted trillium creates a colourful forest quilt in spring.

The dissected, higher relief river valleys yield a greater proportion of hardwood vegetation than occurs elsewhere in the Eastern Lowlands Ecoregion. Forests of sugar maple, yellow birch, and beech are few and are confined to well drained sites on higher landscape positions. One such site occurs near Harris Brook Settlement on a hardwood ridge featuring ironwood, sugar maple, and witch-hazel.

Large black cherry grows at a site west of Upper Blackville Bridge, and a patch of black willow occurs downstream at Arbeau

Settlement. Both species are sparsely distributed in New Brunswick.

Most of the unusual or rare plants growing here prefer moist or wet conditions. A floodplain at the junction of the Barnaby and Southwest Miramichi rivers shelters the smooth yellow violet, plus an upland forest with beech, elm, black willow, and ironwood. The giant rattlesnake-plantain grows in a cedar swamp on the Northwest Miramichi River, north of Wayerton. The Quarryville area supports botanical rarities, such as threadfoot and the small-flowered gerardia.

An old black spruce forest just west of Weaver Siding harbours the uncommon purple lesser fritillary butterfly, formerly called the titania fritillary.

The Miramichi River contains the spawning grounds and nursery habitat of one North America's largest populations of Atlantic salmon. Also occurring in the ecodistrict is the only known spawning ground of the southern Gulf of St. Lawrence striped bass population, which also happens to be the northern-most population of this species in the Atlantic Ocean.

The lower Miramichi estuary has numerous salt marshes, bogs, swamps, islands, tidal flats, and other enclaves that are used annually by thousands of birds for nesting and staging areas. Exmoor Island, for instance, is frequented by osprey and many species of waterfowl. Jones Cove, near Miramichi City, is an important feeding ground for ducks, despite its proximity to human disturbances.

Settlement and Land Use

The Red Bank Ecodistrict lies within the traditional Mi'kmaq territory of Gespegeog and encompasses the famous Oxbow archaeological site located on the Little Southwest Miramichi River, adjacent to the community of Red Bank. The site shows almost unbroken habitation dating back at least 2800 years, which means that Red Bank (Metepenagiag) is New Brunswick's oldest continuously occupied village.

The Augustine Mound just north of Red Bank dates back 2400 years and contains artifacts showing that aboriginals from the area maintained close connections with people in the Ohio River Valley from about 2500 to 2000 years ago. Both the Augustine Mound and Red Bank sites are National Historic Sites.

Metepenagiag is strategically placed between forest and marine resources. As a result, the population always had a thriving trade in surplus food and other items. In pre-colonial days, its residents lived beside the rivers in spring and summer, catching and preserving sturgeon, salmon and other fish. In fall, they traveled to coastal marshes for migratory bird hunts and, in winter, they moved inland to hunt deer, moose, and caribou.

French and English fur traders began visiting the ecodistrict by at least the 1600s. Acadian families appear to have settled along the the Little Southwest Miramichi River in the early 1700s, followed in 1765 by William Davidson who dealt in fish, furs, shipbuilding, and masts. Succeeding merchants preserved fish, secured huge timber licenses, and erected sawmills and shipbuilding facilities at Newcastle and Chatham.

Bog manganese deposits are common here, but have not been commercially developed. More important were the sandstone quarries located at French Fort Cove and Quarryville, which shipped dimension stone to markets across eastern Canada between 1885 and the early 1900s. Stone from French Fort Cove in Newcastle was used to build the Langevin Block of the Ottawa Parliament Buildings.

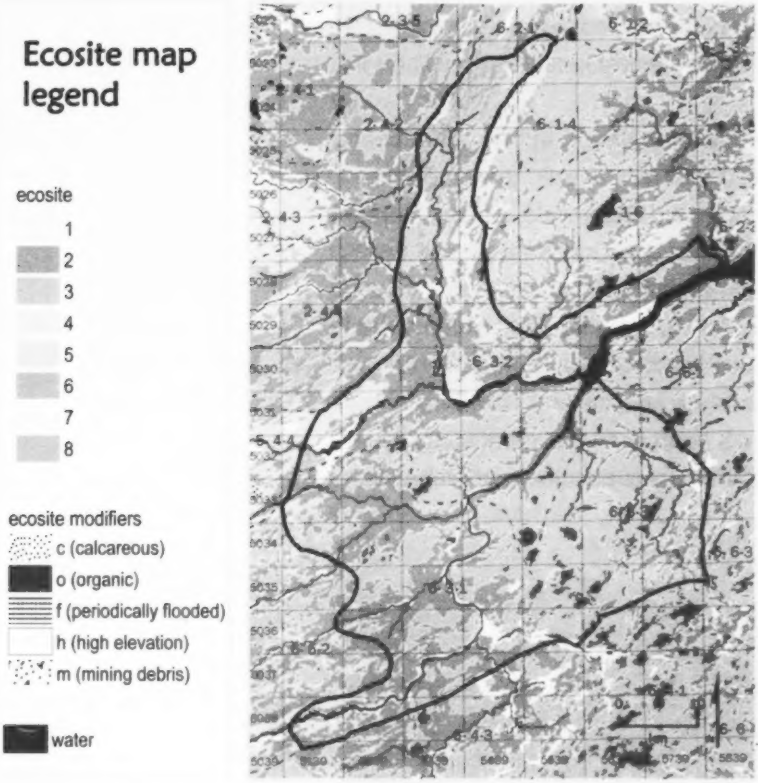
The largest centre in the ecodistrict today is Miramichi City, which includes the former towns of Newcastle and Chatham. Most other communities occur within a narrow fringe paralleling rivers and streams. The pulp and paper industry is a major area employer.

Until the opening of the Centennial Bridge in 1967, a ferry crossed the Miramichi River between Chatham and Douglastown. Several communities including Chatham and Douglastown were amalgamated in 1995 to form the city of Miramichi. *Photograph © Ron Garnett–AirScapes.ca.*

6.3. Red Bank Ecodistrict at a glance

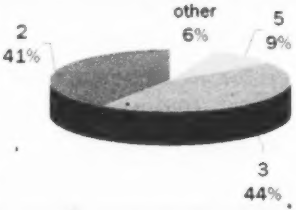
Ecoregion: Eastern Lowlands
Area: 223,981 ha
Average elevation above sea level: 71 m
Average May–September precipitation: 425 mm
Average annual degree-days above 5°C: 1600–1800

Ecosite map legend


ecosite
1
▨ 2
▨ 3
4
5
▨ 6
7
▨ 8
ecosite modifiers
c (calcareous)
■ o (organic)
f (periodically flooded)
h (high elevation)
m (mining debris)
■ water
2-3-5
6-2-1
6-2-2
2-4-1
2-4-2
6-1-4
2-4-3
6-1-6
2-4-4
6-3-2
6-6-1
5-4-4
6-6-3
6-3-1
6-6-2
6-4-3
km

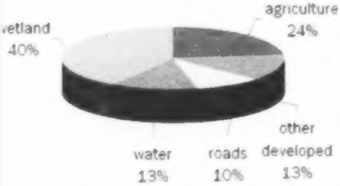
86% of Red Bank Ecodistrict has forest

ecosite coverage of forest area

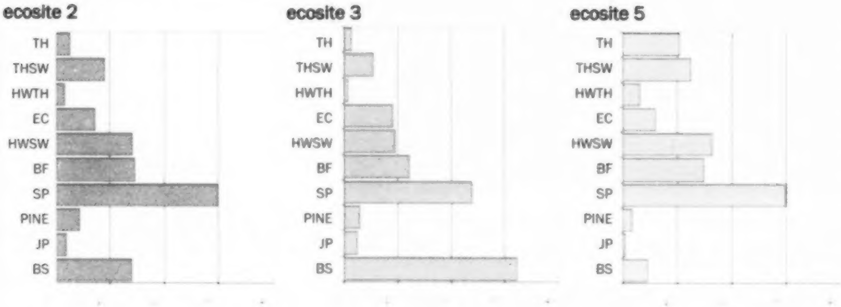


14% of Red Bank Ecodistrict is not forested

uses of non-forest area



forest cover of ecosites



Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.

6.4. Castaway Ecodistrict

The Castaway Ecodistrict is a low, flat plateau that represents the height of land between the Kouchibouguac and Grand Lake Ecodistricts.

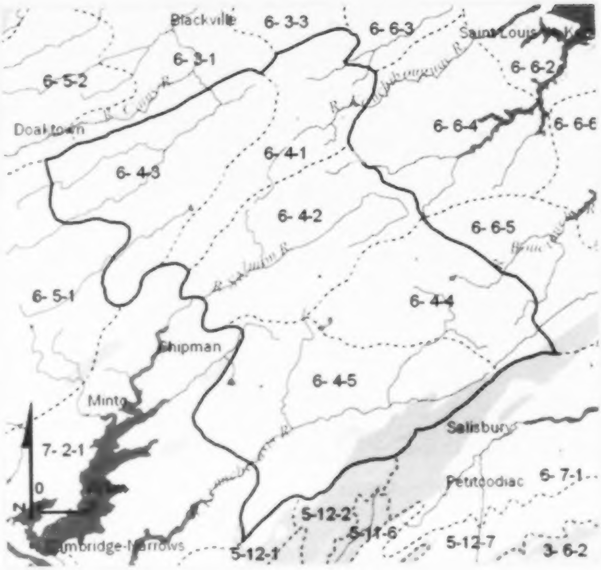
Geology

The bedrock consists almost entirely of Pennsylvanian grey and red sandstone, mudstone, and conglomerate. Near the southern border at New Canaan, a patch of Silurian volcanic rocks underlies a long, narrow band of Mississippian sediments that include limestone and other evaporites.

Landscape and Climate

The Castaway Ecodistrict is a landscape characterized by three major rivers interrupted by large tracts of bog and other wetlands. It has limited human settlement but abundant habitat for flora and fauna.

The Salmon River flows southwest into the Saint John River via Grand Lake, draining much of the central part of the ecodistrict. The Canaan River lies farther south and enters Washademoak Lake, also within the Saint John watershed. The Cains River, skims the northern corner of the ecodistrict before joining the Southwest Miramichi River.



Geology of Castaway Ecodistrict

Rock Types

Highly calcareous sedimentary

▨ Calcareous sedimentary

Non-calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites

Lakes here are small and round, as they have little in the way of bedrock, geological lineaments, or topography to persuade them into more elongate forms. Relief rarely exceeds 60 m, and peak elevations reach only 160 m. Without exception, the lakes appear as suspended bodies of water fed by, and lying within, an almost continuous array of peat bogs, and other wetlands.

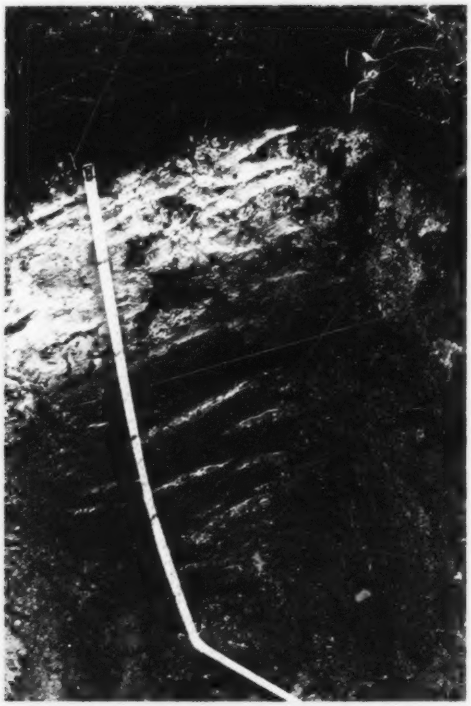
Soils

The Pennsylvanian bedrock weathers easily to produce deep, fine-textured, acidic soils of low inherent fertility, which combine with the poor regional drainage to limit forest growth in the ecodistrict.

The dominant soil is red, fine-textured, clay loam of the Stony Brook Unit. The clay-rich layers effectively limit the infiltration of precipitation, giving the area a wet and boggy aspect. In many areas, a thin layer of medium- to coarse-textured, grey soil of the Harcourt

Unit overlies the red tills. Several peat deposits yielding organic soil are found near Lake Stream Lake and Meadow Lake.

The Cains River basin is covered with compact sandy loam to loamy soils with a medium-coarse texture. They derive from olive green sandstone and belong to the Reece Unit. The slopes of the river, are dominated by non-compact, stony Sunbury Unit soils.



The Castaway Ecodistrict is underlain by clay loam subsoils of low permeability such as the one pictured here. Forest productivity is low overall, except where very gentle slopes contribute to improved drainage.

Biota

Black spruce with jack pine is common on all ecosites, a consequence of fire and acidic, poorly drained soil. These communities occur on a variety of sites including moist flatlands (2), dry valley bottoms (1), and areas of impeded drainage (3). Cedar also grows in flat, swampy areas, such as Lake Stream and Fulton Brook.

White pine dominates over red pine in this area of the province, but at several locales, such as the banks of the West Branch Sabbies River, the two species can be found together.

Hemlock is absent from tracts exposed to repeated wildfire, but can be observed in more fire-protected zones. The land southeast of Shinnickburn near the Sabbies River contains patches of large, old hemlock, which, thus far, have managed to avoid both flame and chainsaw. Hemlock also prevails on woodlots along the eastern border, where roads and fields serve as fire breaks.

Stands of mixed forest occupy the low ridges *(5)* and valley slopes (4) and are dominated by red maple, trembling aspen, birch, red spruce, white spruce, and white pine. As in all of the Eastern Lowlands Ecoregion, forests of sugar maple, yellow birch, and beech are uncommon. One site near New Scotland, however, has remarkably large beeches that are free of the ubiquitous canker disease. As well, the Cranberry Lake Ecological Reserve protects an unusual community of mature red oak and red maple. Native hop recently was discovered at Sabbies Forks, just north of the hemlock stand. It had not been confirmed in New Brunswick since the 1880s and was believed to have been extirpated.

Settlement and Land Use

The Castaway Ecodistrict lies primarily within traditional Maliseet territory, but was used by both Maliseet and Mi'kmaq for overland passage between the Northumberland coast and the Saint John River. The most popular route was up the Richibucto River to a short portage, which led, to the Salmon River, Grand Lake, and the Saint John River. A number of ancient encampments dating back 3000 years have been found along the Salmon River. As well, archaeologists have uncovered some of the earliest pottery fragments in New Brunswick from this ecodistrict.

The area produced large volumes of timber in the early 1800s, much of which was felled along valleys of the Cain, Canaan, and Salmon Rivers. Sawmills were operating along the Sabbies River by at least the 1820s.

The peatland-forest mosaic pictured here is typical of the plateau captured in the Castaway Ecodistrict.

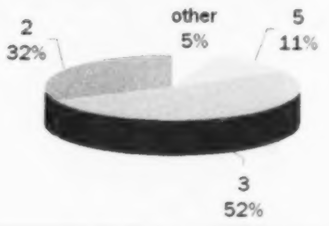
Lumber camps aside, the widespread wetlands of the ecodistrict precluded much historic non-aboriginal habitation. A few villages arose elsewhere, including at Castaway, which was named for an island at the mouth of the Salmon River where two men fell off their scow in the early 1800s. The 1870s arrival of the Intercolonial Railway created railside communities, such as Coal Branch, Canaan, and Rogersville. Rogersville grew into a thriving agricultural centre alongside a Trappist Monastery, which was established in 1902. Rogersville is called the Brussel Sprout Capital of Canada in recognition of the large brussel sprout plantation established in 1966. It also derives economic benefit from nearby peat harvesting operations.

6.4 Castaway Ecodistrict at a Glance

Ecoregion: Eastern Lowlands
Area: 424, 618 ha
Average elevation above sea level: 71 m
Average May-September precipitation: 400 - 425 mm
Average annual degree-days above 5°C: 1700

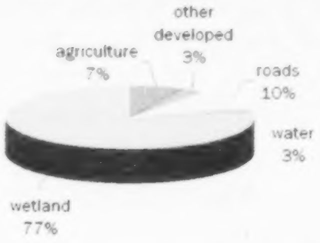
95% of Castaway Ecodistrict has forest cover

ecosite coverage of forest area



5% of Castaway Ecodistrict is not forested

uses of non-forest area



Ecosite map legend

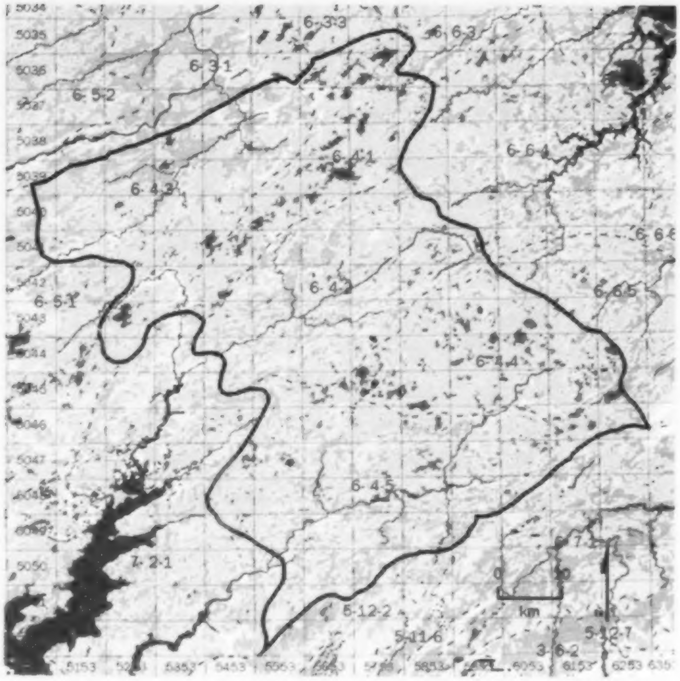
ecosite

- 1
- ▨ 2
- ▨ 3
- 4
- 5
- ▨ 6
- 7
- ▨ 8

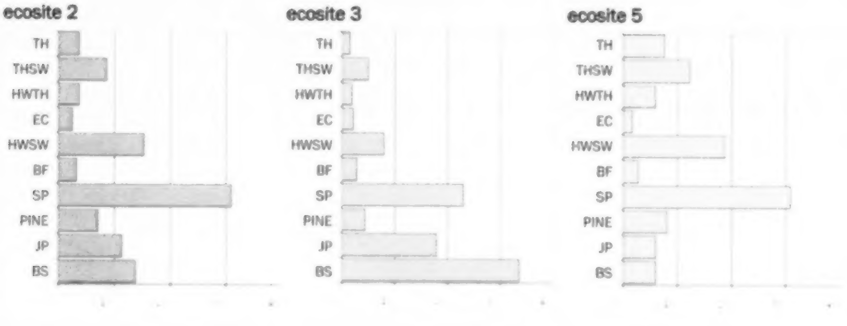
ecosite modifiers

- ⁘ c (calcareous)
- ■ o (organic)
- ≡ f (periodically flooded)
- ☐ h (high elevation)
- ⁘ m (mining debris)

■ water


6-3-3
6-6-3
6-3-1
6-5-2
6-4-1
6-6-4
6-4-3
6-6-6
6-4-2
6-5-1
6-6-5
6-4-4
6-4-3
7-2-1
6-7-2
5-12-2
5-11-6
5-12-7
3-6-2
0
10
km

Percent cover of forest stand types by ecosite



Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis:** percent cover.

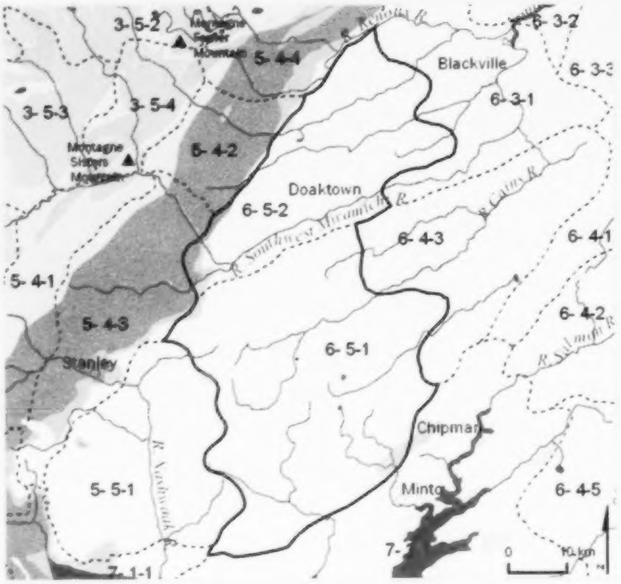
6.5. Bantalor Ecodistrict

The Bantalor Ecodistrict is a flat to gently rolling area located on the edge of the Eastern Lowlands Ecoregion where they abut the Valley Lowlands Ecoregion.

Geology

Geological formations in this ecodistrict are composed mainly of Pennsylvanian non-calcareous grey to red sandstone, mudstone, and conglomerate. Roadcuts near Astle display typical Pennsylvanian strata with conglomerate, grading up into cross bedded sandstone, a sequence indicative of ancient river channels. Plant fossils can be seen at the site.

The bedrock throughout is flat lying and easily eroded, characteristics that have combined to create an unusual feature on Newcastle Creek between Mount Pleasant and Hurley Brooks. Here, waters of the creek have undercut a steep bank by almost 8 m to produce an overhang known locally as the Devil's Oven.



Geology of Bantalor Ecodistrict

Rock Types

Highly calcareous sedimentary

Calcareous sedimentary

Non-calcareous sedimentary

Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites

Landscape and Climate

The Southwest Miramichi River is the dominant physiographic feature. It transects the terrain as a wide, island-filled watercourse with steep sides that in places rise 60 m to attain an average elevation of 150 m. A few streams leading into the Southwest Miramichi, such as Betts Mills Brook and Burnt Land Brook, are also deeply incised. Relief elsewhere in the ecodistrict scarcely exceeds 40 m. Betts Mills was named after Ephraim Betts, who is credited with being the earliest non-aboriginal resident in the upper Miramichi area. His settlement near Doaktown dates from 1795.

Many streams and brooks entering the Southwest Miramichi are important salmon spawning grounds. Most of the major rivers (the Dungarvon, Bartholomew, Cains, Muzoll and Gaspereau) flow in northeast, parallel to the Southwest Miramichi River rather than draining directly into it, at least in this ecodistrict. The phenomenon seems related to the fact that the landscape lacks any defining topographic features, such as mountains or deep valleys, to affect river flow direction. Instead, the waters simply follow the northeasterly structural trend of the bedrock that dominates most of New Brunswick.

Once beyond the borders of the Bantalor Ecodistrict, some rivers angle to join the Southwest Miramichi, some flow directly into it, while others head southward into Grand Lake.

The area is relatively warm, but receives limited moisture because it lies in a rain shadow of the Central Uplands Ecoregion. The dry climatic conditions have contributed to frequent fires in the past, the most famous being the 1825 Miramichi Fires.

Soils

As with most of the Eastern Lowlands Ecoregion, the Bantalor Ecodistrict's combination of poor drainage plus droughty, coarse-textured, and acidic soils has limited forest productivity. Most of its soil units are derived from grey, lithic-feldspathic sandstone.

Coarse-textured soils of the Sunbury Unit are found around North Cains, Timber Lake, and on upper slopes of the Cains and Miramichi rivers. Shallow, residual soils of the Fair Isle Unit are associated with the more strongly dissected slopes along brooks feeding the Miramichi and Cains rivers.

The relatively deep, loamy, acidic soils of the Reece Unit have slow internal drainage and produce numerous wet sites. Several extensive peat deposits near Gaspereau and Muzroll Lakes have contributed to soils of the Organic Unit.

A small area of glaciofluvial deposits with deep, coarse-textured, gravelly soil and belonging to the Gagetown Unit occurs near Boiestown along the Taxis River. These soils derive mainly from volcanic bedrock, and likely reflect a tiny zone of Mississippian basic volcanic rock that touches the western edge of the ecodistrict.

Biota

Tolerant hardwood stands of sugar maple, yellow birch, beech, and red maple occur only on slopes and ridgetops (7) along the western border. The steep slopes of the Southwest Miramichi River possess good drainage in an ecodistrict that otherwise is poorly drained, except in scattered patches.

Moist slopes (5) are dominated by black spruce with red spruce, balsam fir, hemlock, red maple, and yellow birch. The moist flatlands (2) have more black spruce and less hardwood. Black spruce also occurs with tamarack in areas of lower elevation and poorer drainage (3), an expression of their tolerance for wet, poorly oxygenated, and acidic soils.

The widespread stands of early successional species reflect a high fire frequency; they consist of red maple, grey, and white birch, with some jack pine. Elsewhere, black spruce and red spruce are prominent.

White pine tends to grow on coarse-textured soils (1) along the Miramichi, Dungarvon, and Bartholomew Rivers. Cedar is more common at slightly higher elevations in the west, possibly reflecting an association with nutrient-rich seepage areas of calcareous bedrock.

Several sites here are important staging areas for migratory waterfowl. These include Burnt Land Brook Lake, the east branch of lower Otter Brook, and Cranberry Bog.

The Southwest Miramichi River, near Doaktown.

The most significant bog for rare or uncommon flora is located at Bull Pasture Plains. It is the first New Brunswick site for a rare moss (*Splachnum pennsylvanicum)* and also hosts the attractive orchid, grass-pink.

Settlement and Land Use

The Bantalor Ecodistrict encompasses traditional territories of both the Maliseet and Mi'kmaq. Although ancient native settlements have yet to be found here, the area has a high potential for the discovery of early aboriginal villages at major river confluences. The land was used regularly for hunting trips and also for overland passage between the Saint John and Miramichi river systems.

Two popular portage routes existed. The first led from the Saint John River up the Nashwaak River to Cross Creek, crossed a portage to the Taxis River, and from there linked to the Southwest Miramichi River. The second route began with paddling up Grand Lake to the Gaspereau River, portaging to the Cains River, and then canoeing to the Miramichi River.

The major communities in the ecodistrict are Boiestown and Doaktown, which had their origins at the turn of the 19th century. The first non-aboriginal settlers were dissatisfied Loyalists, who, in 1795, opted to move from their original land grants up to what they thought were greener pastures along the upper Miramichi River.

Unfortunately, the soils of the land were little suited for agriculture.

Not until the 1820s arrival of American capitalist Thomas Boies did their settlement begin to boom. He established a thriving business with a farm, grain mills, carding mills, and lumber works, creating the basis for what is now Boiestown. Around the same time, Scottish capitalist Robert Doak set up business just downriver with shops, mills, and kilns; the settlement evolved into the village of Doaktown.

Both Doaktown and Boiestown faltered in the 1840s, largely because the surrounding forests had been depleted of the best wood. Visitors to both communities in 1851 found little but abandoned fields and inactive mills. Fortunes, changed with the 1887 completion of the Canada Eastern Railway between Chatham and South Devon. The railroad opened new areas for timber development, and also conveyed American sportsmen into the area.

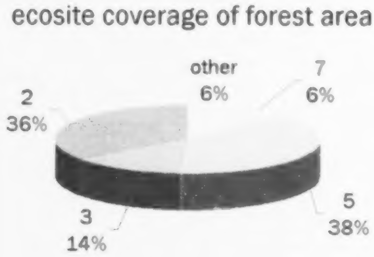
The economic livelihoods of Doaktown and Boiestown today rely on outfitting, salmon fishing, tourism, and timber. Their central location along Highway 8 also enables residents to find employment in the larger centres of Fredericton and Miramichi City.

The most common economic mineral in the area is coal, which formerly was excavated from several locations along the southern border of the ecodistrict.

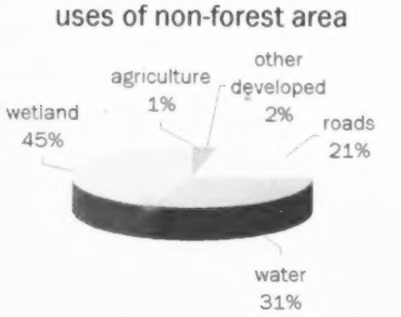
6.5. Bantalor Ecodistrict at a glance

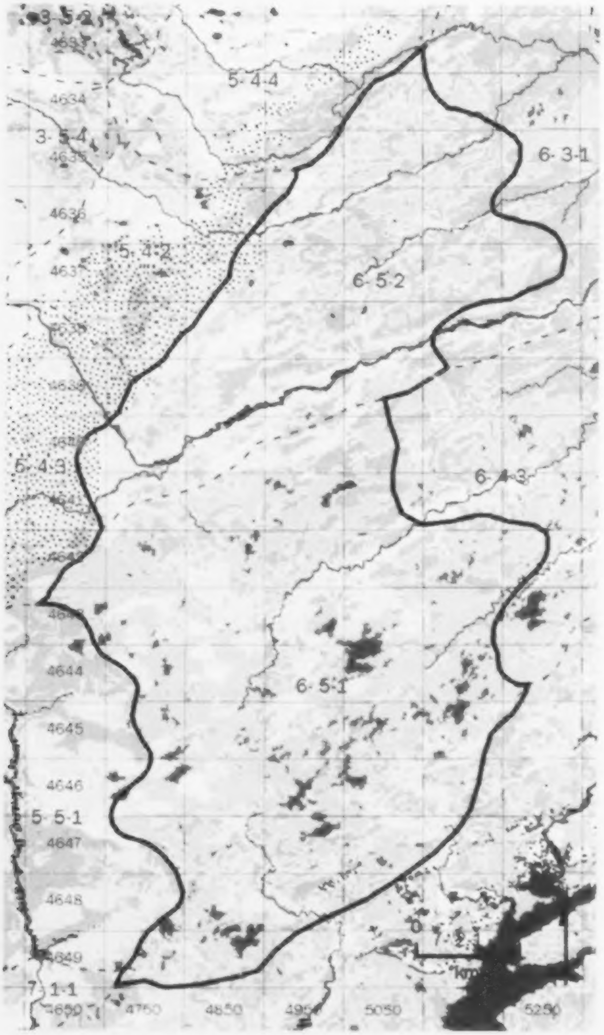
Ecoregion: Eastern Lowlands
Area: 250, 072 ha
Average elevation above sea level: 140 m
Average May–September precipitation: 400–475 mm
Average annual degree-days above 5°C: 1650

87% of Bantalor Ecodistrict has forest cover



17% of Bantalor Ecodistrict is not forested




3-5-2
4633
5-4-4
4634
3-5-4
4635
4636
5-4-2
4637
6-5-2
6-3-1
4638
5-4-3
6-4-3
6-5-1
4644
4645
4646
5-5-1
4647
4648
4649
7-1-1
4650
4750
4850
4950
5050
5250
7-2
km

Ecosite map legend

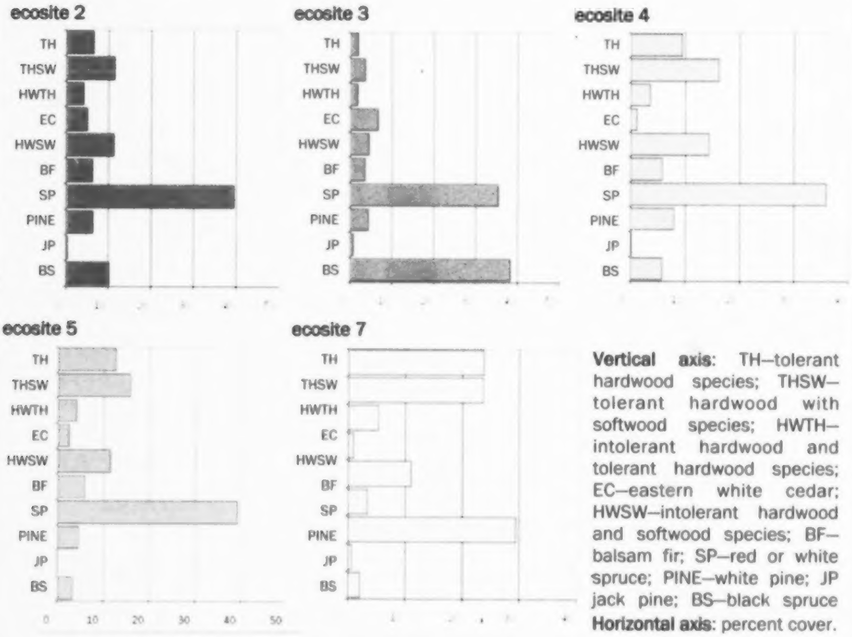
ecosite

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

ecosite modifiers

- c (calcareous)
- o (organic)
- f (periodically flooded)
- h (high elevation)
- m (mining debris)
- water

Percent cover of forest stand types by ecosite



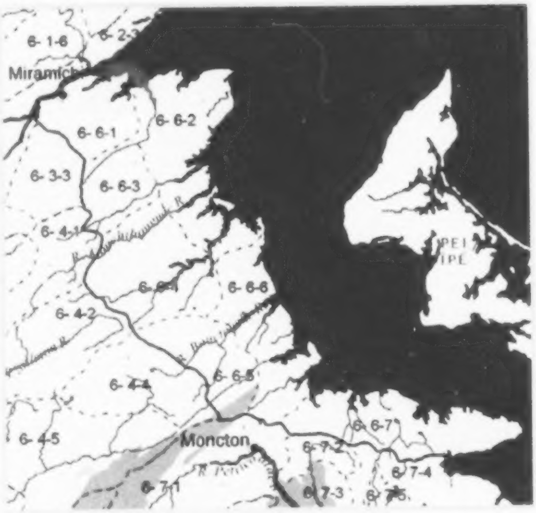
Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.

6.6. Kouchibouguac Ecodistrict

The Kouchibouguac Ecodistrict encompasses the eastern coastline of the province reaching from Miramichi Bay to Cape Tormentine, and is dominated by river estuaries, sand dunes, and peat bogs.

Geology

The bedrock is composed entirely of Pennsylvanian grey and red sandstone, mudstone, and conglomerate. Rocks on the Cape Tormentine Peninsula contain red micaceous sandstone and slightly calcareous mudstone that are similar to redbed lithologies found in parts of Prince Edward Island.



Geology of Kouchibouguac Ecodistrict

Rock Types

Highly calcareous sedimentary
Calcareous sedimentary
Non-calcareous sedimentary
Early Carboniferous sedimentary
Late Carboniferous sedimentary
Mafic volcanic
Felsic volcanic
Granites and granodiorites

Landscape and Climate

The elevation of this flat, low ecodistrict is less than 60 m near the coast, then gently rises upward to the west until achieving a maximum of 90 m along the border. The terrain is divided by sprawling river valleys so shallow that the riverbank seldom reaches 25 m above the watercourse.

River estuaries are a dominant feature of the landscape, penetrating up to 30 km inland from the Northumberland Strait. Those associated with the Richibucto, Cocagne and Buctouche rivers are particularly invasive and reflect, in part, the degree of coastal land subsidence that has occurred since the last glacial retreat. The rivers historically were rich in salmon and other fish species.

The Miramichi River estuary straddles this ecodistrict and the Red Bank Ecodistrict (see the Red Bank Ecodistrict for more information on its natural history).

Barrier beaches also are characteristic of the area; the most dramatic appear at Kouchibouguac National Park and the Buctouche Dunes. Peat bogs occur throughout the terrain and in places actually abut the seacoast, where they are being eroded by waves from rising sea levels. The bogs, like the dunes and estuaries, provide varied and valuable habitat for plants and animals. The area has one of the warmest and driest climates in New Brunswick, and a growing season that is exceeded only by that of the Central Lowlands Ecoregion. At Point Escuminac, an eroded bog reveals tree fragments from a forest dating back 4300 years ago.

Soils

Forest productivity is restricted by poor drainage and marine exposures. Even so, the more fine-textured soils, that have a lower content of coarse fragments can be well suited to farming. Most local soils have resulted from a combination of marine deposits near the coastline and glacial tills farther inland.

The barrier beach pictured here is part of Kouchibouguac National Park.

Compact loams to clay loams of the Stony Brook and Harcourt Units are abundant inland. Adjacent to the Northumberland Strait, the sandier quartzose beach soils of the Barrieau-Buctouche and Riverbank Units are more common.

The sandy loam to loamy soils near Cape Tormentine belong to the Parry and Salisbury Units; they are slightly calcareous and are coarser than glacial tills found farther north. Glaciolacustrine deposits occur as fine-textured, clayey deposits of the Tracadie Unit and are situated near the Black and Bay du Vin Rivers.

Biota

Three hundred years of settlement in this ecodistrict have resulted in widespread early successional hardwood forests with trembling aspen, red maple, and white birch. Later successional forests consist primarily of coniferous stands and mixed forests. Forests of red maple, sugar maple, and beech, together with spruce and hemlock grow in localized enclaves.

Black spruce stands grow on the widespread areas of poorly drained soils (3), whereas pure jack pine stands commonly occur along the rivers, where soils are sandier (1). Forests in the immediate vicinity of the Northumberland Strait are dominated by white spruce. The trees often are stunted with deformed and damaged crowns, reflecting repeated exposure to wind and salt spray. Cape Tormentine to the south has extensive stands of tamarack.

Communities of tolerant hardwoods with red maple and balsam fir tend to grow on the better drained slopes on sites with fine-textured soils (5); the communities possess a higher proportion of red spruce where soils are more coarsely textured (2).

Forest fragmentation by human settlement has tended to inhibit fire in much of the area, leading to a scarcity of pine. Hemlock and cedar, however, are fairly abundant. Red oak grows within a cedar stand on an island at Cape Jourimain, and is an unusual species in this area of low fire frequency.

Two protected natural areas have been designated in the Kouchibouguac Ecodistrict: Kouchibouguac National Park, in the north, and the Cape Jourimain National Wildlife Area, in the south. In addition, the Bouctouche Dunes have become an area managed for tourism and conservation. All three locales are remarkable for their diversity of unusual plants. Among other species, Cape Jourimain contains a saltmarsh aster and Green's rush, both of which are very rare.

However, it is in the realm of bird habitat that these protected areas–and, indeed, the entire coastline of this ecodistrict– achieve world recognition. The dunes at Kouchibouguac National Park and Buctouche are favoured nesting sites by piping plover. This shorebird and its habitat are recognized as nationally endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and are protected under the provincial *Endangered Species Act*. In addition, large numbers of waterfowl, seabirds, and shorebirds use Cape Jourimain, the Richibucto estuary, Kouchibouguac, Bouctouche Bar, and other locations along this coast as staging areas for seasonal migrations, performing a ritual far more ancient than human civilization itself.

Peat harvesting near Pointe-Sapin. *Photograph © Ron Garnett--AirScapes.ca.*

Settlement and Land Use

The ecodistrict encompasses much of the traditional Mi'kmaq territory of Sigenigteoag. Many important villages or burial grounds were located at the mouths of rivers such as the Scoudouc, Buctouche, Richibucto, Black, and Aldouin, and on Shediac Island. For about 3000 years before European contact, the people relied on the area's plentiful marine resources throughout much of the year, moving inland only for brief winter hunting expeditions.

The Northumberland coastline was one of the earliest areas in the province to be inhabited by non-aboriginals. The first settlers likely were French or Acadian and were later joined by British immigrants. Lumbering proceeded vigorously in the area after 1800 as its rivers provided easy access for loggers and adequate transport for felled timber.

By the 1850s, the villages of Shediac, Bouctouche, Cocagne, and Richibucto were well established with sawmills, shipbuilding factories, and an active agricultural industry. The 1860 completion of the European and North American Railway between Saint John and Shediac connected the region to larger markets in Saint John and other centres.

The landscape and people of this ecodistrict have been immortalized in the work of Acadian author Antonine Maillet. The Pays de la Sagouine brings many of the characters in her fictional work to life on an island in Buctouche Bay.

Today, lumbering and agriculture remain important contributors to the local economy, along with tourism, fishing, and peat harvesting. Agricultural activities occur on about 9% of the land area. They consist mainly of mixed farming, with beef cattle dominating over pasture, forage, grain, and horticultural crop production.

Mining once played a significance role here, partly because of coal mines in the Beersville area, but mainly because of the Smith sandstone quarry near Shediac. The operation opened around 1810 and, for the next 140 years, produced dimension stone and grindstones for markets across eastern Canada.

6.6. Kouchibouguac Ecodistrict at a Glance

Ecoregion: Eastern Lowlands
Area: 518, 929 ha
Average elevation above sea level: 48 m
Average May-September precipitation: 375 - 425 mm
Average annual degree-days above 5°C: 1600 - 1800

Ecosite map legend

ecosite

☐ 1
▨ 2
▨ 3
▨ 4
▨ 5
▨ 6
▨ 7
▨ 8

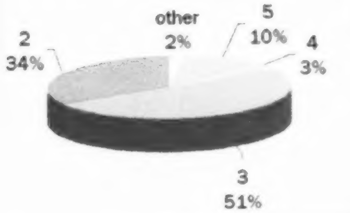
ecosite modifiers

▨ c (calcareous)
■ o (organic)
▤ f (periodically flooded)
☐ h (high elevation)
▨ m (mining debris)

■ water

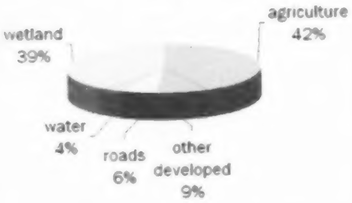
75% of Kouchibouguac Ecodistrict has forest cover

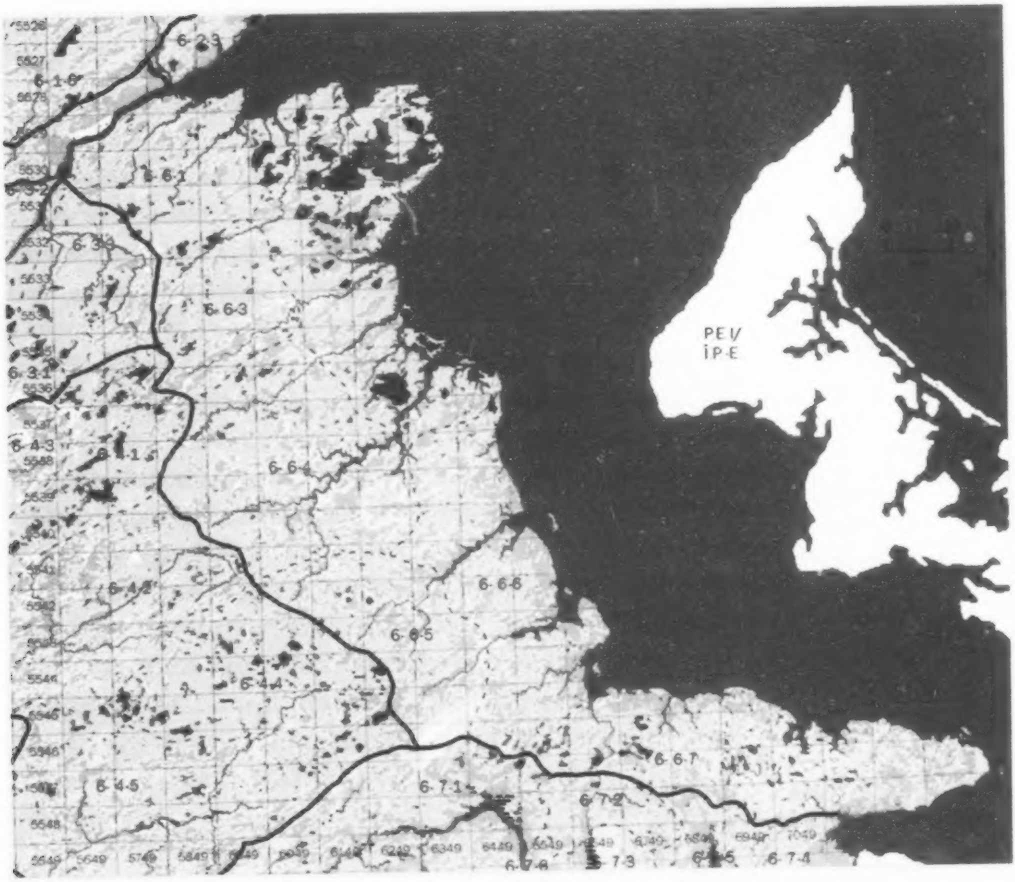
ecosite coverage of forest area



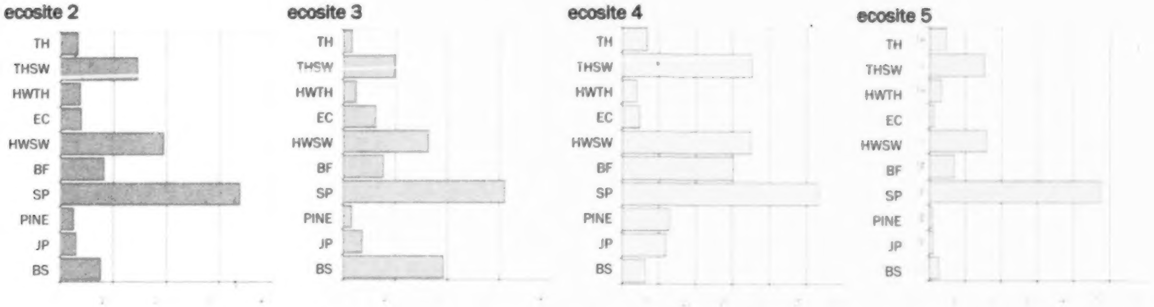
25% of Kouchibouguac Ecodistrict is not forested

uses of non-forest area




6-2-3
6-1-6
6-6-1
6-3-2
6-3-3
6-6-3
6-3-1
6-4-3
6-4-1
6-6-4
6-4-2
6-6-6
6-6-5
6-4-4
6-6-7
6-4-5
6-7-1
6-7-2
6-7-6
6-7-3
6-7-5
6-7-4
PEI/
ÎP-É

Percent cover of forest stand types by ecosite



Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.

6.7. Petitcodiac Ecodistrict

The Petitcodiac Ecodistrict is a low-lying, gently rolling area with ridges and valleys that encompass the broad Petitcodiac River basin.

Geology

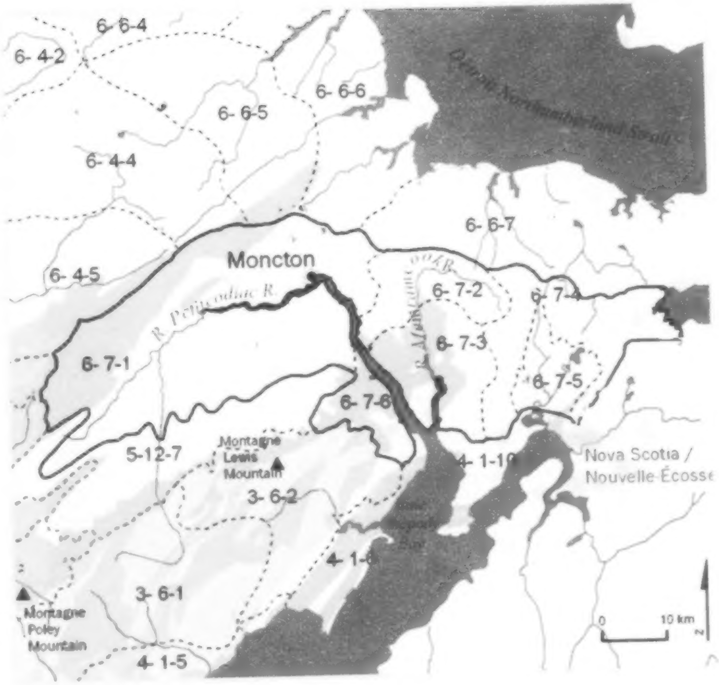
The predominant rocks in this ecodistrict are non-calcareous Pennsylvanian sandstone, conglomerate, and mudstone that range from grey to red. Redbeds tend to occur near Port Elgin, where sedimentary rocks typically are reddish, slightly calcareous, and micaceous.

Mississippian strata occur patchily across the ecodistrict. They consist mainly of red and grey sandstone with conglomerate, overlain by limestone, gypsum, and other evaporites.

The Mississippian rocks appear in four main areas. The largest zone forms a band paralleling the ecodistrict's northwest border between Cornhill and Lutes Mountain. A roughly circular pocket straddles the Petitcodiac River between Memramcook in the east and Beech Hill in the west. Two patches occur on the southern tip of the Maringuoin Peninsula and farther east in the vicinity of Aulac. A small plug of Precambrian granite outcrops just east of Calhoun, where it is quarried and crushed for aggregate.

Landscape and Climate

The name Petitcodiac derives from the Mi'kmaq *epetkutgoyek* meaning *'the river bends around in a bow'*. Petitcodiac River dominates the landscape. It begins as North River in the boggy plateau of the Castaway Ecodistrict and flows southwest to meet the Anagance River at the village of Petitcodiac. There, it becomes known as the Petitcodiac River and turns abruptly northeast to parallel the regional bedrock structure until reaching Moncton, where it angles sharply again to pour southward into a huge river estuary and Shepody Bay. In the days of brigs and schooners, its outgoing tide was so powerful that a ship could be carried from upriver out to the open sea without hoisting a sail.



Geology of Petitcodiac Ecodistrict

Rock Types

- Highly calcareous sedimentary
- Calcareous sedimentary
- Non-calcareous sedimentary
- Early Carboniferous sedimentary
- Late Carboniferous sedimentary
- Mafic volcanic
- Felsic volcanic
- Granites and granodiorites

To the east, the Memramcook and Tantramar rivers also arise in wetlands before flowing south through estuaries into Shepody Bay. The former river travels through the village of Memramcook and the latter, along the outskirts of Sackville. The combined effects of the three rivers - the Tantramar, Memramcook and Petitcodiac - is to define two peninsulas of land that jut into Chignecto Bay to create Shepody Bay on the west and Chignecto Bay on the east.

Karst topography is a distinctive feature of the ecodistrict. The deposits of gypsum and limestone in areas of Mississippian bedrock are susceptible to solution in circulating groundwater, which results in the formation of caves, sinkholes, and funnel-shaped depressions. Petitcodiac has a rare honeycombed karst occurrence west of town, where sinkholes the size of a small car tire alternate with ridges just wide enough for a footstep. One of the longest gypsum cave networks in eastern Canada is near Hillsborough and is an important habitat for hibernating bats.

Elevations here generally are less than 75 m, except north of Moncton where Steeves Mountain and Indian Mountain peak at about 165 m. Lutes Mountain sits 150 m above the city of Moncton, which is flanked on its south side by the famous Magnetic Hill.

The area's climate is transitional between the warm, dry

Eastern Lowlands Ecoregion and the cool, wet Fundy Coast Ecoregion.

Soils

Relatively rich soils in this ecodistrict are represented by alluvial material of the Interval Unit and tidal deposits of the Acadia Unit. These soils occur along the Petitcodiac and Memramcook rivers and have been intensively farmed.

The Parry and Salisbury units contain fine-textured soils derived from red, slightly calcareous sandstone and mudstone. These clay loams to loams have good granular structure and, if well drained, are the most fertile glacial tills in the ecodistrict. Where the bedrock is locally more conglomeratic, soils tend to form the coarser, sandy loam to loam material of the Parleeville-Tobique Unit, which is less fertile.

Looking southward, we see the Petitcodiac River south of Moncton near St-Anselme and Lower Coverdale. *Photograph © Ron Garnett–AirScapes.ca.*

North of Dorchester, a bedrock of grey sandstone and red mudstone has produced strongly acidic, medium-textured loams to sandy loams of the Harcourt and Stony Brook units, which are only moderately fertile.

Biota

Red spruce dominates the forest here, together with white spruce, black spruce, balsam fir, red maple, white birch, and trembling aspen (2, 3, 5). Other species such as tamarack, white pine and hemlock, may be present. Hemlock can also occur in tiny, but pure, stands.

Black spruce grows in scattered patches in the vicinity of peat bogs (3o) on soils of the Organic Unit and in the coastal marsh. Jack pine tends to be present in areas affected by repeated fires. Cedar occurs in bogs (3b) and also over limestone and gypsum bedrock. Roadsides near Mannhurst and Kinnear Settlement support calcareous-loving plants, including rufous bulrush.

Tolerant hardwood stands of sugar maple, beech, and yellow birch are found only on ridgetops or upper slopes (7), especially over slightly calcareous soils. The high frequency of disturbed sites dominated by aspen stands reveals the degree of historical and recent human disturbance along the Petitcodiac River.

Freshwater and saltwater marshes provide valuable habitat for many species of waterfowl and other birds. Two areas are particularly significant: the Tantramar Marshes and the Shepody Bay Ramsar site.

The Tantramar Marshes are a tidal area covering some 10,000 ha near Sackville. Their maroon and buff-coloured grasses echo the red and grey soils beneath, an aesthetic detail that has been appreciated by various New Brunswick poets and painters.

The Tantramar area encompasses Ram Pasture and Coles Island Marsh at the Tantramar River mouth, the Sackville Waterfowl Park in east Sackville, and the Upper Tantramar Marsh farther north. Birdwatchers visit the area each year for the Sackville Waterfowl Festival, eager for views of willet, rail, American bittern, shorebirds, and waterfowl. The Upper Marsh is one of New Brunswick's few confirmed nesting sites for marsh wren and Virginia rail.

One of the more exotic features in the ecodistrict is a bog in the Upper Tantramar Marshes. It contains springs and pools so rich in copper that coniferous seedlings die before reaching a height of 10 cm. Specialized mosses and algae, however, seem to thrive around the seepage areas.

The Tantramar area is also one of very few confirmed New Brunswick sites for the bronze copper butterfly, whose larvae feed on great water dock growing in the marsh. Another butterfly visitor is the crowberry blue, which frequents coastal bogs and while in its larval stage eats black crowberry.

The Shepody Bay Ramsar site covers much of Shepody Bay and adjoins the Mary's Point Ramsar site, located in the adjacent ecodistrict. Borth Ramsar sites protect wetlands of international significance. Together, they constitute the Shepody Bay Western Hemispheric Shorebird Reserve (WHSRN), an area famous for its huge flocks of semipalmated sandpipers, semipalmated plovers, and other shorebirds.

Settlement and Land Use

The Petitcodiac Ecodistrict lies within the traditional Mi'kmaq territory of Sigenigteoag. It intersected the main portage route between the Bay of Fundy and Gulf of St. Lawrence, and possessed multiple resources such as shellfish, waterfowl, seabirds, wild rice, and sweet grass. Although little is known about early native villages in the area, it likely supported many settlements over its several thousand years of aboriginal habitation.

The first non-aboriginal inhabitants were Acadian families, who settled the area in the 1600s and built dykes to drain the marshes, creating some of the most fertile farmland in the North America. They also constructed the first dry dock in Canada at the confluence of the Aulac and La Coupe rivers, about 8 km from Cumberland Basin.

The cities of Moncton (foreground) and Dieppe (background) occupy "The Bend" of the Petitcodiac River, pictured here. *Photograph © Ron Garnett–AirScapes.ca.*

In 1766, immigrants from Saxony via Pennsylvania moved onto the dyked and other lands around present-day Moncton. The Germans subsequently were joined by Planters from New England, as well as by Acadians returning from exile.

By the 1860s, The Bend (later called Moncton) and Sackville had become centres of agriculture, shipbuilding, stove manufacture, and education. In Sackville, Mount Allison University was established in 1839. The Université de Moncton, founded in 1963, has its roots in French language institutions that were created in this region and in northern New Brunswick in the 1860s. Sackville and, especially, Moncton evolved into major railway centres after completion of the Intercolonial Railway in the 1870s.

The Petitcodiac Ecodistrict consistently had among the lowest lumber exports in the province throughout the first half of the 19th century. This appears to have been a result of occupational diversity, including shipbuilding, rather than a lack of timber.

Regional mineral resources also were varied. Gypsum and grindstone quarries were the mainstay mining occupations - the Hillsborough gypsum quarries and local grindstone quarries had operated steadily since the late 1700s - but people also worked deposits of building stone, coal, manganese, oil shale, copper, barite, lead, natural gas, and oil.

Carboniferous sandstone from quarries near Sackville and Dorchester was shipped across the province and the country. The red Sackville stone can be seen in many Mount Allison University buildings and in the Ontario parliament buildings in Toronto.

Mining in the ecodistrict essentially ceased in 1982 with closure of the gypsum quarries, however there is renewed interest in exploration for minerals, oil, and gas. Farming remains economically important. Agriculture occurs on 17% of the total land area and is predominantly mixed farming, with crop production supplemented by dairy and beef operations. Pasture and hay are the most common crops, followed by alfalfa, oats, and other grains.

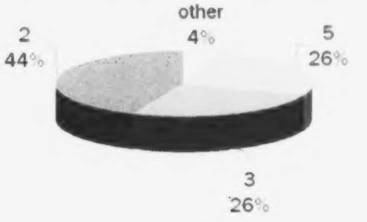
Moncton is the major economic centre, and greater Moncton is now the largest urban area in New Brunswick.

6.7. Petitcodiac Ecodistrict at a Glance

Ecoregion: Eastern Lowlands
Area: 218, 075 ha
Average elevation above sea level: 67 m
Average May-September precipitation: 415 - 450 mm
Average annual degree-days above 5°C: > 1700

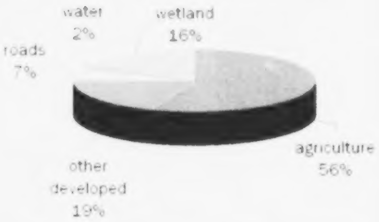
70% of Petitcodiac Ecodistrict has forest cover

ecosite coverage of forest area



30% of Petitcodiac Ecodistrict is not forested

uses of non-forest area



Ecosite map legend

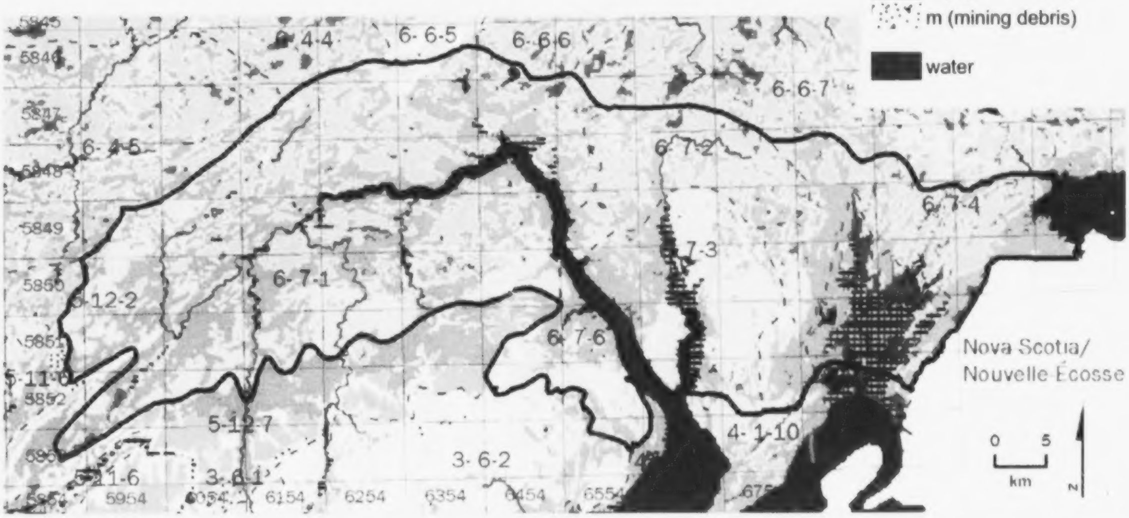
ecosite

1
▨ 2
3
4
5
▨ 6
7
▨ 8

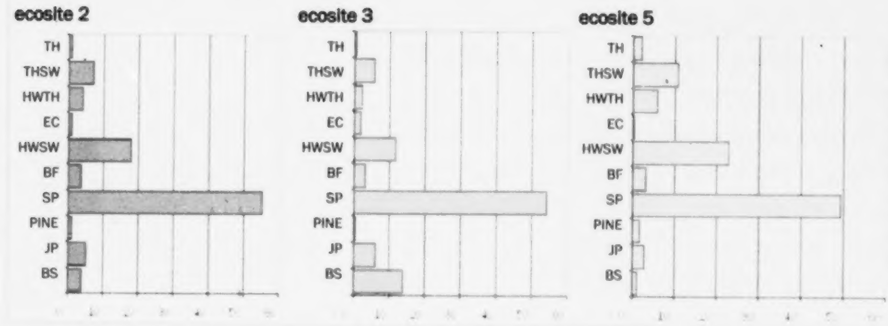
ecosite modifiers

c (calcareous)
o (organic)
f (periodically flooded)
h (high elevation)
m (mining debris)

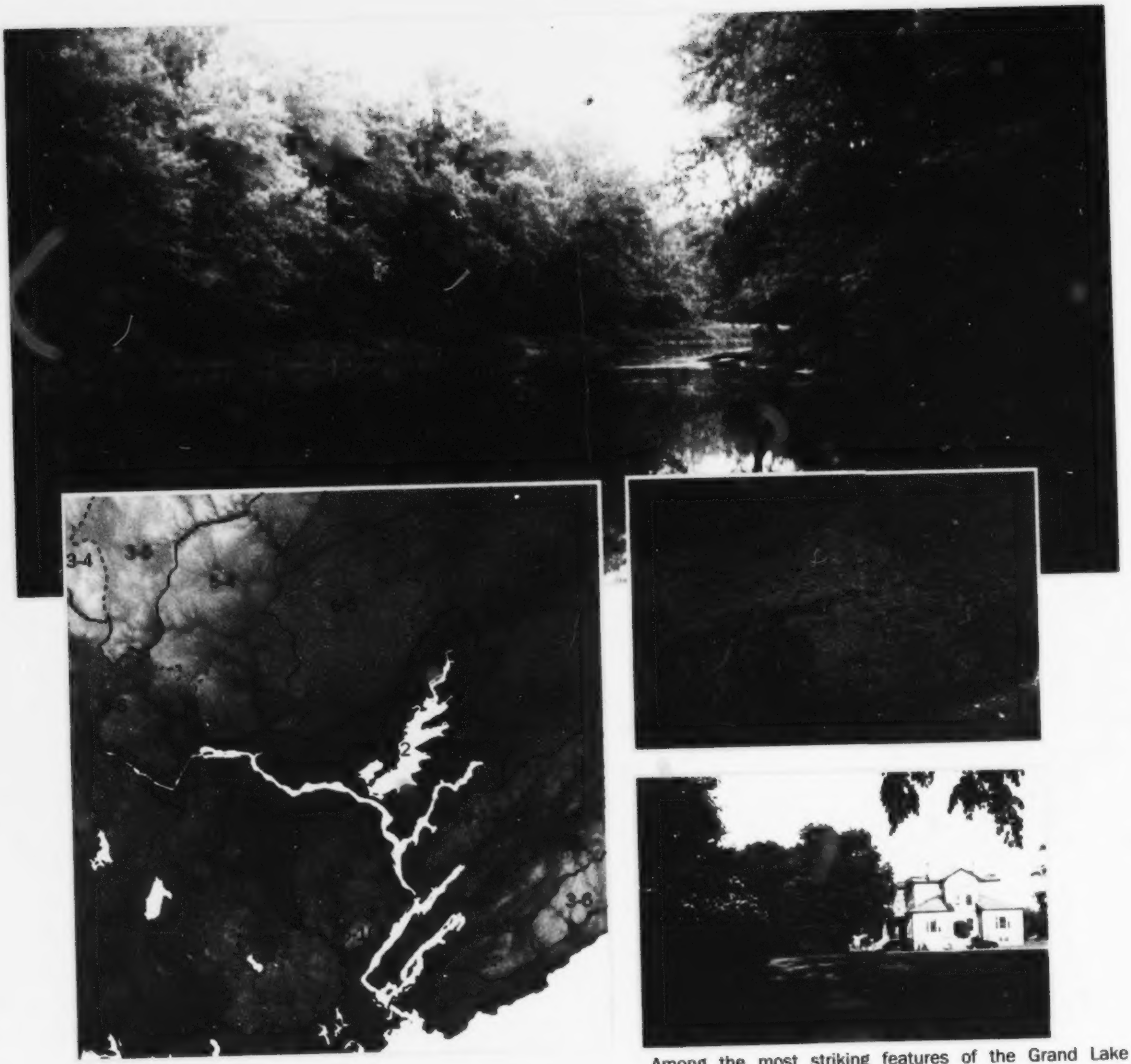
■ water


5845
5846
5847
5848
5849
5850
5851
5852
5853
5954
6054
6154
6254
6354
6454
6554
6654
6-4-4
6-6-5
6-6-6
6-6-7
6-4-5
6-7-2
6-7-4
6-7-1
7-3
5-12-2
6-7-6
5-11-6
5-12-7
4-1-10
3-6-2
5-11-6
3-6-1
Nova Scotia/
Nouvelle Écosse
0 5
km
N

Percent cover of forest stand types by ecosite



Vertical axis: TH–tolerant hardwood species; THSW–tolerant hardwood with softwood species; HWTH–intolerant hardwood and tolerant hardwood species; EC–eastern white cedar; HWSW–intolerant hardwood and softwood species; BF–balsam fir; SP–red or white spruce; PINE–white pine; JP jack pine; BS–black spruce **Horizontal axis**: percent cover.

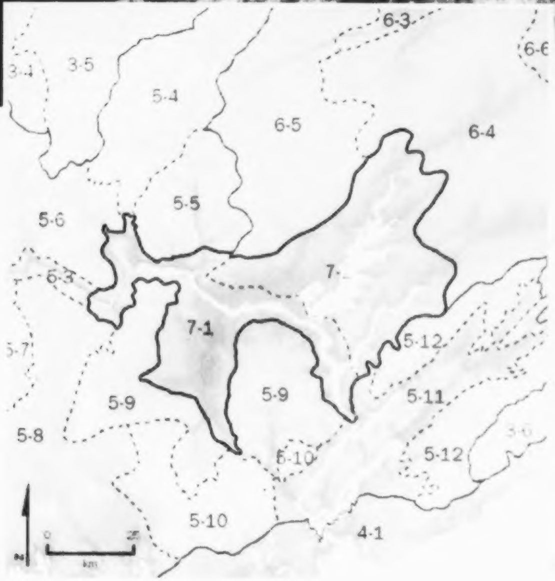


Among the most striking features of the Grand Lake Lowlands Ecoregion are the extensive, shrub-dominated and forested alluvial wetlands, pictured above. Also shown is Old Government House in Fredericton.

Chapter 13

7. Grand Lake Lowlands Ecoregion

The Grand Lake Lowlands Ecoregion in central New Brunswick encompasses the Grand Lake basin, the Oromocto River watershed, and the floodplains surrounding the mid-section of the lower Saint John River between Prince William and Evandale. This region is distinguished by its widespread alluvial floodplains and the warmest climate in New Brunswick.



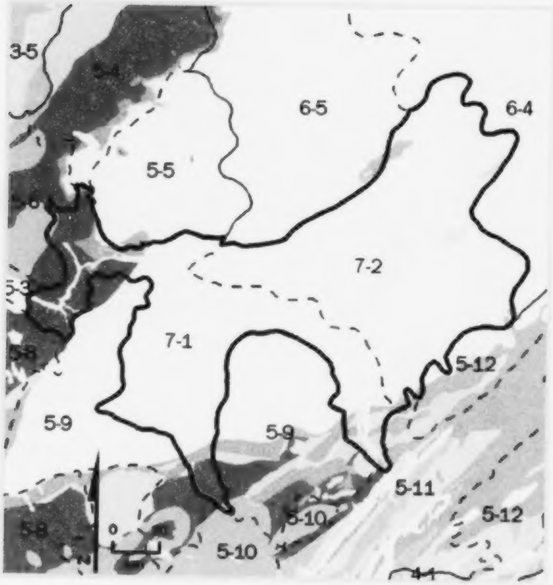
Among the most striking features of the Grand Lake Lowlands Ecoregion are the extensive, shrub-dominated and forested alluvial wetlands, pictured above. Also shown is Old Government House in Fredericton.

Chapter 13

7. Grand Lake Lowlands Ecoregion

The Grand Lake Lowlands Ecoregion in central New Brunswick encompasses the Grand Lake basin, the Oromocto River watershed, and the floodplains surrounding the mid-section of the lower Saint John River between Prince William and Evandale. This region is distinguished by its widespread alluvial floodplains and the warmest climate in New Brunswick.

The moist, rich soils, combined with the lengthy growing season, have yielded a unique assemblage of southern vegetation species that depend on regular inundations by the silty, nutrient-laden waters.



Grand Lake Lowlands Ecoregion Rock Types

Highly calcareous sedimentary
Calcareous sedimentary
Non-calcareous sedimentary
Early Carboniferous sedimentary
Late Carboniferous sedimentary
Mafic volcanic
Felsic volcanic
Granites and granodiorites

Geology and Landscape

The ecoregion is composed almost entirely of Carboniferous, non-calcareous sedimentary rocks, ranging from fine siltstones through sandstones to coarse conglomerates. The western and southern extremities are underlain by small sections of calcareous and non-calcareous sedimentary rocks of Ordovician and Silurian age. The topography forms a low-lying trough centred on Grand Lake, with expansive, shallow river valleys. Elevation ranges from about 150 m, west of Fredericton to just above sea level along the floodplains of the lower Saint John River. Three waterways dominate the landscape: Grand Lake, the Saint John River, and the Oromocto River, which enters the Saint John through a maze of wetlands. Although tidal effects reach up the Saint John River as far as Fredericton, they are overridden in spring by the greater influence of widespread flooding. The spring floods affecting the Saint John and Oromocto rivers carry the accumulated meltwater from the entire Saint John River watershed and create an extensive floodplain along the Saint John and Oromocto rivers. The waters creep over bottomland forests, fields, marshes, peatlands, and open water wetlands. Water normally recedes by late May or early June, leaving behind a thin, new layer of soil. The constantly replenished soil plus the fluctuating water levels together are partly responsible for the ecoregion's diversity in vegetation and wetland types.

Climate

The Grand Lake Lowlands Ecoregion represents the provincial hot spot, with the longest growing season and warmest summer temperatures in New Brunswick. Grand Lake covers about 165 sq km and acts as a huge heat sink for the area. It stores heat over the summer and releases it slowly over the fall and early winter, thus moderating the climate and bringing an extended frost-free period to the surrounding land.

Forest Cover

This ecoregion of rich alluvial soils, unusually warm climate, and extended growing season contains the province's largest number of tree species and greatest abundance of southerly species. Heat-loving trees such as ironwood, basswood, white ash, green ash, northern red oak, and silver maple are relatively common here.

Spring flooding is integral to the cycle of many floodplain species, as exemplified by the silver maple, whose seeds require wet soil to germinate. Silver maple swamps are especially prevalent in floodplains of the Saint John and Oromocto rivers and some of their tributaries. The tree is one of three floodplain species—bur oak and butternut being the other two—that are well adapted to sites with high flooding frequency, and that are scarce in New Brunswick outside the ecoregion.

The slightly higher intervale locations were covered by American elm in former times, with red oak, red maple, and white ash also occurring on better drained gravel bars, levees or beaches. On beach sites where ice scour is more prevalent, green and black ash also occur.

The low relief of the region makes for few tolerant hardwood ridges. Tolerant hardwood stands containing ironwood, beech, white ash, sugar maple, yellow birch, and occasionally basswood, occur on well drained soils beside lakes and on a few higher elevation sites. Significant stands of butternut still remain on a few islands below the Mactaquac Dam.

Upland areas surrounding the lakes and river valleys are covered with communities of red maple, red spruce, hemlock, beech, sugar maple, and white ash. White pine appears on well drained, glaciofluvial deposits in the region, although repeated lumbering has greatly lessened its populations in those locales. White pine also makes a significant showing where the ecoregion borders the Eastern Lowlands Ecoregion, as do such as black spruce, red spruce, red pine, and jack pine.

Characteristic understorey species in the Grand Lake Ecoregion tend to be associated with aquatic habitats or otherwise damp conditions. Their common names reveal this watery affinity: swamp milkweed, riverbank grape, waterweed, and water-plantain.

Wetlands

The striking diversity of wetlands in this ecoregion results from three factors: the presence of Grand Lake, the extensive floodplains along the Saint John and Oromocto rivers, and the span of water levels over the growing season. Wetland types range from non-peatlands (such as swamp, marsh, and shallow water) to floodplain peatlands that feature extensive fen or minerotrophic vegetation. Extensive areas of marshlands, including seasonally flooded meadows, occur along the Saint John River, mainly within the floodplain. Lakeshores have widespread cover vegetation, featuring sweet gale and other shrubby species. Streamside alder swamps are also present here, although the diversity of wetlands in this ecoregion relegates them to a less prominent feature than in the Northern Uplands or Highlands ecoregions.

7.1. Aukpaque Ecodistrict

The Aukpaque Ecodistrict lies in south-central New Brunswick, encompassing much of the broad, low-lying valleys of the Saint John and Oromocto Rivers.

Geology

The bedrock is composed mainly of Pennsylvanian sedimentary rocks, including grey sandstone, conglomerate, and red mudstone of the Petitcodiac Group. It also includes three areas of older rocks: these occur south of Washademoak Lake, northwest of Fredericton, and around Enniskillen.

The terrain south of Washademoak Lake consists of sedimentary and volcanic rocks ranging in age from Silurian to Mississippian, with an intrusive stock of Devonian granite in the vicinity of Evandale. Upriver from Fredericton, Silurian to Mississippian calcareous and non-calcareous sedimentary strata occur with isolated plugs of basic volcanic rock. Silurian to Mississippian sedimentary and volcanic rocks also underlie the landscape around Enniskillen. Plant fossils are visible in Pennsylvanian sandstone outcrops just below the Highway 101 bridge over the North Branch Oromocto River at Fredericton Junction.

Geology of Aukpaque Ecodistrict

Rock Types

Highly calcareous sedimentary

Calcareous sedimentary

Non-calcareous sedimentary

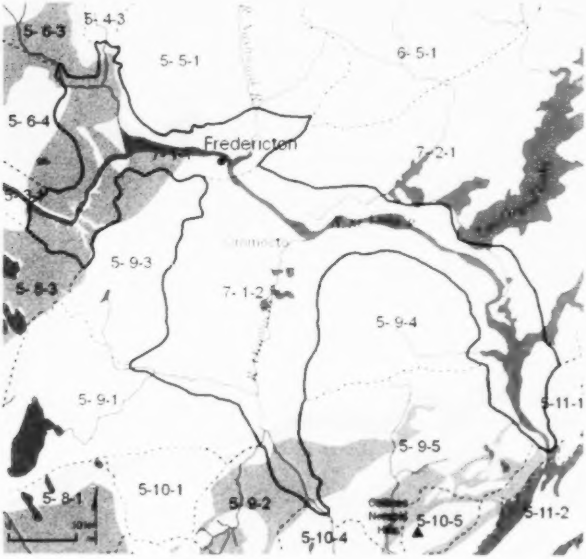
Early Carboniferous sedimentary

Late Carboniferous sedimentary

Mafic volcanic

Felsic volcanic

Granites and granodiorites



Landscape and Climate

The lower Saint John River flows southeastward through the terrain, flanked along the Saint John and Oromocto rivers, and the span of water levels over the growing season. Wetland types range from non-peatlands (such as swamp, marsh, and shallow water) to floodplain peatlands that feature extensive fen or minerotrophic vegetation. Extensive areas of marshlands, including seasonally flooded meadows, occur along the Saint John River, mainly within the floodplain. Lakeshores have widespread cover vegetation, featuring sweet gale and other shrubby species. Streamside alder swamps are also present here, although the diversity of wetlands in this ecoregion relegates them to a less prominent feature than in the Northern Uplands or Highlands ecoregions.

7.1. Aukpaque Ecodistrict

The Aukpaque Ecodistrict lies in south-central New Brunswick, encompassing much of the broad, low-lying valleys of the Saint John and Oromocto Rivers.

Geology

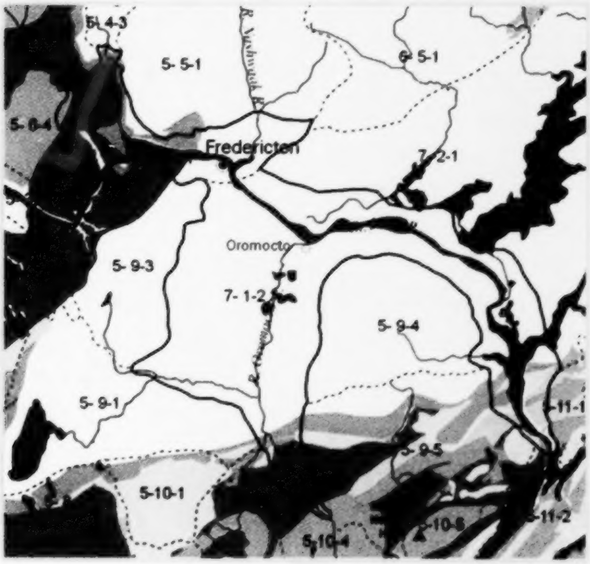
The bedrock is composed mainly of Pennsylvanian sedimentary rocks, including grey sandstone, conglomerate, and red mudstone of the Petitcodiac Group. It also includes three areas of older rocks: these occur south of Washademoak Lake, northwest of Fredericton, and around Enniskillen.

The terrain south of Washademoak Lake consists of sedimentary and volcanic rocks ranging in age from Silurian to Mississippian, with an intrusive stock of Devonian granite in the vicinity of Evandale. Upriver from Fredericton, Silurian to Mississippian calcareous and non-calcareous sedimentary strata occur with isolated plugs of basic volcanic rock. Silurian to Mississippian sedimentary and volcanic rocks also underlie the landscape around Enniskillen. Plant fossils are visible in Pennsylvanian sandstone outcrops just below the Highway 101 bridge over the North Branch Oromocto River at Fredericton Junction.

Geology of Aukpaque Ecodistrict

Rock Types

- Highly calcareous sedimentary
- ■ Calcareous sedimentary
- ░ Non-calcareous sedimentary
- ▒ Early Carboniferous sedimentary
- Late Carboniferous sedimentary
- ▓ Mafic volcanic
- ░ Felsic volcanic
- ▒ Granites and granodiorites



Landscape and Climate

The lower Saint John River flows southeastward through the terrain, flanked by lushly vegetated floodplains. The river overflows annually, laying alluvial debris over older sediments that were deposited 10,000 to 12,000 years ago by glacial Lake Acadia.

Glacial Lake Acadia occupied much of the lower Saint John River valley and was formed by an ice near present-day Saint John. When the dam broke, the lake emptied into the Bay of Fundy.

The Saint John River constantly reworks its riverine and old lacustrine sediments into a shifting chain of alluvial islands that stretches from Upper Shores Island in the north to Spoon Island in the south. These islands are a defining feature of the landcape and, in summer, are dotted with cattle quietly grazing on community pasture lands.

Portobello Creek, in the Portobello National Wildlife Area, is a protected area administered by the Canadian Wildlife Service.

Several major rivers enter the Saint John in this region, most notably the Naskwaak, Mactaquac, Keswick, and Oromocto rivers. The Oromocto River displays a series of glacially derived ponds, marshes and bogs that constitute the Oromocto River Wetland Complex. The complex represents important habitat for resident and migrating waterfowl, as well as for aquatic mammals. Two Eastern Habitat Joint Venture sites occur within the complex: Shaw Creek and Oromocto West. Washademoak Lake, farther south, is actually the widened lower reach of the Canaan River, which arises in swampland far to the east in the Castaway Ecodistrict.

Elevations east of Fredericton tend to be less than 100 m, whereas those west of the city are somewhat higher. Relief is generally low, except in the west where steep river valleys incise the upland surface by up to 150 m. Isolated plugs and stocks of igneous rock also provide some topographic variety. Currie Mountain in Douglas, is formed of mafic volcanics, and the hills around Evandale are underlain by resistant granitic bedrock.

The Aukpaque Ecodistrict has a relatively warm and dry climate. The huge volumes of water in the river basins act as a heat reservoir and extend the frost-free season beyond what it would be otherwise.

Soils

The landscape south and east of Fredericton is covered with compact loams to clay loams derived from the easily weathered red mudstone and grey sandstone. These acidic, poorly drained soils belong to the Stony Brook and Harcourt units and are characterized by stands of red spruce, balsam fir, and hemlock.

The floodplains of the Saint John River east of the Mactaquac Dam and along portions of the Keswick River and the Oromocto River valley possess thick beds of alluvial sand and gravel, overlain by silt or fine sand of the Interval Unit. Spring floods that deposit nutrient-rich sediment over the floodplain replenish the intervale zone annually. Where cleared for agriculture, these combined soils sustain fruit, vegetable, poultry, and livestock production.

Shallow loams derived from zones of harder, but slightly calcareous bedrock are found west of Fredericton along the relatively steep slopes of the Saint John River valley and over Keswick Ridge. These fertile soils of the Thibault Unit tend to be covered by tolerant hardwood stands of sugar maple, yellow birch, beech, and white ash.

Biota

The dominant forest is a mixture of red spruce, balsam fir, sugar maple, and beech, with significant white pine and hemlock (5). Currie Mountain, west of Fredericton supports a representative forest this type. It is covered by sugar maple, red oak, hemlock, and mature white pine, with a rich understorey that includes round-leaved hepatica and several species of fern. Odell Park, in nearby Fredericton protects 400-year-old hemlock, with beech and sugar maple.

Communities of sugar maple, red maple, ironwood, basswood, and red oak occur on better drained soils at low elevations (7c, 8c), and black cherry occurs locally throughout. White ash and red oak, in particular, are found on raised, sandy beaches along the shores of Grand Lake and the Saint John River, and also on more upland sites.

White pine is associated with the drier, glaciofluvial deposits that are not subject to flooding (1). By contrast, eastern white cedar stands tend to prefer seepage slopes over calcareous bedrock (4c, 6c) and moist to wet sites, such as bogs. Tower Lake near Fredericton is good example of a bog lake and is surrounded by cedar, tamarack, red maple, and black spruce, with a ground cover of small cranberry and pitcher plants.

The original forest has been altered dramatically by agriculture on the Interval Unit soils, and by forest harvesting and clearing for settlement and agriculture along valley slopes and peripheral flatlands. Stands of red maple, white birch, grey birch, balsam fir, and trembling aspen are typical of these disturbed areas.

Some of the most distinctive ecosites in the area are the most intriguing from an arboreal standpoint, and help to define the ecodistrict. They occur on Interval soil and floodplains and are characterized by tree species that usually display warmer, more southern affinities. These species include silver maple, American elm, butternut, bur oak and green ash, all of which thrive on the sheltered, seasonally flooded lands of the Saint John River. They are especially evident on islands in the vicinities of Douglas and Jemseg (6b, 7b). Gilbert Island near McGowans Corner, for instance, has silver maple, butternut, and American elm.

The wetlands and floodplain islands also possess a rich floral diversity, a function, in part, of their repeated flooding, rich soils, and moderated climate. Shore Island is one of several islands with shore vegetation that remains in a state of early succession due to flooding; it harbours such rarities as yellow oxytropis and Brunet's milk-vetch. Tall dropseed was rediscovered on Shore Island in 1993. Other rare plants located in this ecodistrict are pine drops at Keswick Ridge, early saxifrage at Douglas, and fringed violet along an old railway line in North Fredericton.

The Nashwaak River flows into the Saint John River at Fredericton. This area provides alluvial forest habitat, agricultural products, timber, and important recreational and cultural opportunities for Fredericton residents.

Many alluvial islands along the Saint John and Oromocto rivers and their associated wetlands represent significant habitat for waterfowl, shorebirds, gulls, osprey, and black tern. The largest and most crucial wetland is Grand Lake Meadows, which is used heavily by inland waterfowl during spring migration and sees several breeding species of ducks each summer.

Sandbars along this lower portion of the Saint John River and its tributaries harbour one of only a few known Canadian populations of yellow lampmussel.

Just downriver from Shore Island, at Barkers Point, is the annually flooded Hyla Park Nature Preserve, which shelters clammy hedge-hyssop and purple milkwort. Hyla Park is also home to three species of salamanders, plus seven species of toads and frogs, including a disjunct population of the eastern gray treefrog. This former gravel pit is the most northeasterly known habitat for the eastern gray treefrog in North America and is Canada's first park set aside to conserve amphibian species.

Settlement and Land Use

The Aukpaque Ecodistrict lies within traditional Maliseet territory. Many Maliseet encampments existed along the Saint John River, including ones at Gagetown, Oromocto, Jemseg, and Maugerville.

A more recent Maliseet community lay on the outskirts of present-day Fredericton and occupied part of Hartts and Savage islands, plus the south riverbank opposite the islands. It was called Aukpaque and was settled in the early 18th century by aboriginals who had moved downriver from an older village at Meductic. When Aukpaque was granted to a Loyalist in 1794, the natives shifted upriver to Kingsclear and beyond.

The French made their first attempts to inhabit the lower Saint John River valley during the mid-1600s, and, in 1695, constructed the province's first sawmill at the mouth of the Nashwaak River.

By the mid-1800s, the rich intervale lands, warm climate and natural resources had attracted successive waves of French, Acadians, Planters, Loyalists, English, Irish, and Scots. The valley became one of the most heavily settled areas in the province, with residents relying mainly on farming and logging. Many people in the Hampstead area also worked at the local granite quarries. The quarries first opened in the 1830s and today provide material for the local market. The granite appears in many New Brunswick structures, including the Old York County Gaol and the piers of old Carleton Street Bridge, both in Fredericton.

A view of the Mactaquac hydroelectric dam with Keswick Ridge rising behind it. The ridge is underlain by slightly calcareous sedimentary rocks. *Photograph © Ron Garnett–AirScapes.ca.*

The southern extension of the ecodistrict east of the Oromocto River is part of the Canadian Forces Base Gagetown. The village of Gagetown is recognized as an important centre for artisans; it originally was known as Grimross, a name derived from the

Maliseet *eklimlass* meaning *settlement place.*

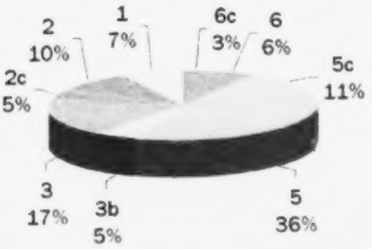
Sand and gravel deposits and crushed rock quarries are worked here to fulfil the ecodistrict's increasing demand for highway and building aggregate. Agriculture also is an important land-use activity, especially in the Keswick and Saint John river valleys, where farm operations provide fruits, vegetables, meat, and dairy products for the larger Fredericton market.

7.1. Aukpaque Ecodistrict at a Glance

Ecoregion: Grand Lake Lowlands
Area: 168, 552 ha
Average elevation above sea level: 54 m
Average May–September precipitation: 425–450 mm
Average annual degree-days above 5°C: 1650–1800

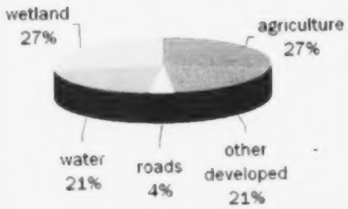
62% of Aukpaque Ecodistrict has forest cover

ecosite coverage of forest area



38% of Aukpaque Ecodistrict is not forested

uses of non-forest area

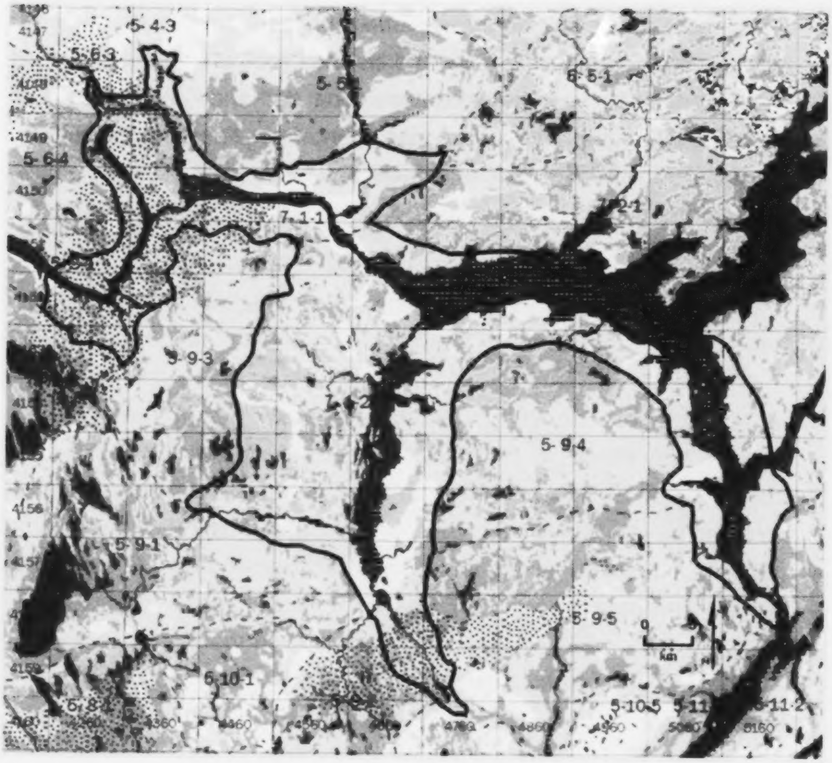


Ecosite map legend

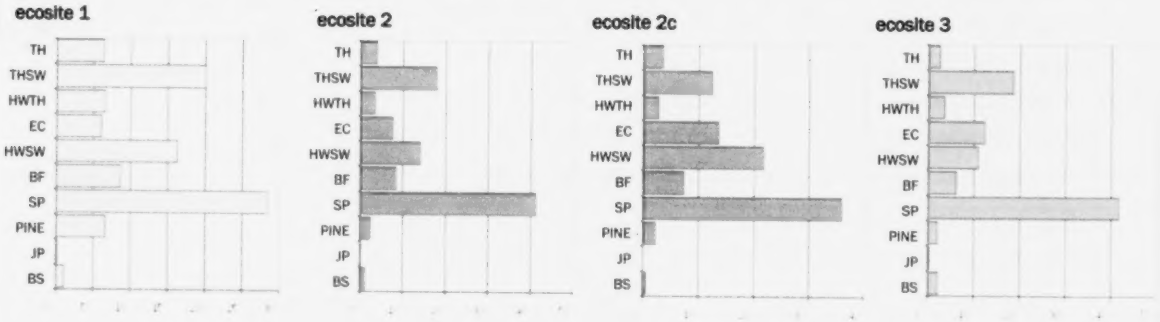
ecosite
- 1
- ▨ 2
- ▨ 3
- 4
- 5
- ▨ 6
- 7
- ▨ 8

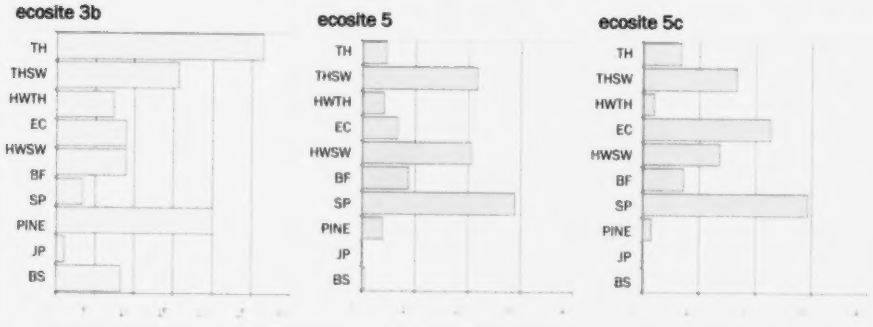
ecosite modifiers
- ⁘ c (calcareous)
- ■ o (organic)
- ☰ f (periodically flooded)
- ☐ h (high elevation)
- ⁘ m (mining debris)

■ water


5-4-3
5-6-3
5-6
6-5-1
5-6-4
7-1-1
2-1
5-9-3
7-1-2
5-9-4
5-9-1
5-9-5
0
km
5-10-1
5-8-1
5-10-5
5-11
5-11-2
4147
4148
4149
4150
4156
4157
4159
4360
4460
4560
4660
4760
4860
4960
5060
5160

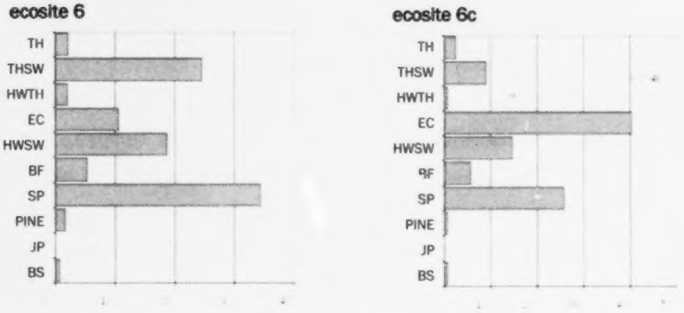
Percent cover of forest stand types by ecosite





Vertical axis: BS—black spruce; JP jack pine; PINE—white pine; SP—white spruce; BF—balsam fir; HWSW—intolerant hardwood and softwood species; EC—eastern white cedar; HWTH—intolerant hardwood and tolerant hardwood species; THSW—tolerant hardwood with softwood species; TH—tolerant hardwood species. **Horizontal axis**: percent cover.

Percent cover of forest stand types by ecosite (continued)



7.2. Maquapit Ecodistrict

The Maquapit Ecodistrict in south-central New Brunswick forms a flat, low-lying basin area that encloses the waters of Grand, Maquapit, and French Lakes and the major coalfields of New Brunswick.

Geology

The bedrock consists almost entirely of Pennsylvanian red and grey sandstone, conglomerate and red mudstone, interbedded with coal horizons of variable width. Small plugs of Mississippian volcanic rock occur south of Cumberland Bay and in the vicinity of Hardwood Ridge. As well, the bedrock south of Washademoak Lake merges into a more resistant zone of Silurian volcanic rocks that continues beyond the ecodistrict boundary.

Landscape and Climate

The landscape presents a gently sloping basin filled with Grand Lake, Washademoak Lake, and their feeder streams. Elevations are less than 120 m at the ecodistrict perimeter and drop gradually inwards toward Grand Lake.

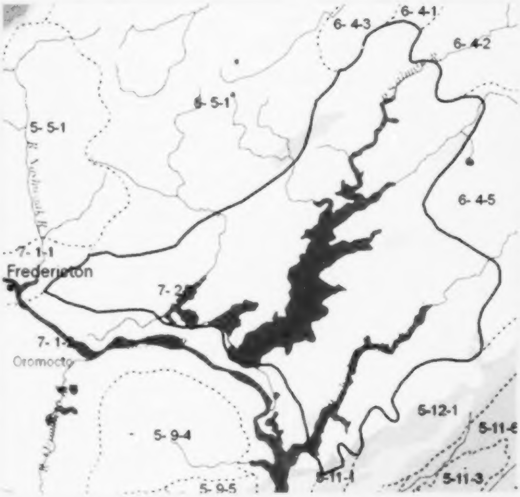
The flat sedimentary strata remain unbroken by major faults or lineaments. Nonetheless, the lakes and their associated waterways course roughly northeasterly, following the prevailing structural grain of bedrock.

The volcanic intrusion near Cumberland Bay

Geology of Grand Lake Ecodistrict

Rock Types

- Highly calcareous sedimentary
- Calcareous sedimentary
- Non-calcareous sedimentary
- Early Carboniferous sedimentary
- Late Carboniferous sedimentary
- Mafic volcanic
- Felsic volcanic
- Granites and granodiorites



has resulted in Cumberland Bay Hill, which stands above the uniform Pennsylvanian terrane. Only in the extreme south of the ecodistrict, beyond Washademoak Lake, does the landscape begin to undulate upwards in anticipation of the higher plateau beyond the border. Otherwise, relief seldom exceeds 30 m, except where streams have managed to eroded the soft bedrock surface. The rivers here tend to meander across the countryside before flowing into Grand Lake. The ones draining into Washademoak Lake are somewhat more sprightly, especially those originating in uplands to the south. A single noteworthy waterfall in the region occurs on a tributary of Chase Brook, northwest of Chipman, where the stream cascades 5 m over irregular bedrock structure.

The Maquapit Ecodistrict is moderately dry and has the warmest climate in the province. The large volumes of water in Grand Lake and the adjacent lower Saint John River act as a heat reservoir to prolong the frost-free period.

Soils

The red, non-calcareous Pennsylvanian strata disintegrate rapidly to yield deep horizons of acidic soil. They occur over much of the ecodistrict and have given rise to widespread areas of red, compact clay loams and loams of the Stony Brook and Harcourt units.

These reddish soils are moderately fertile on the better drained slopes and, around Grand Lake, support crops of vegetables and small fruits. However, the land's lack of relief and the soil's fine texture combine to impede drainage, which limits the growth rate of overlying vegetation.

Shallow, soils of the Sunbury Unit occur sparsely across the ecodistrict in areas underlain by grey, lithic-feldspathic sandstones. Coarse, alluvial soils of the Riverbank Unit overly lower stretches of the Gaspereau and Salmon rivers where they support white pine stands. Fertile soils of the Interval Unit occur along the western boundary where it meets the Aukpaque Ecodistrict.

Biota

The ecodistrict has a large number of tree species. Mixed stands of red spruce and hemlock, with red maple, white birch, and trembling aspen, form the most common forest cover and are associated with the better drained upland soils (5). Hemlock also occurs in more diverse forest communities, such as the Big Cove

Forest on Washademoak Lake, where twenty tree species have been identified, including hemlock, black ash, white ash, ironwood, cedar, and pine.

White pine grows throughout but is particularly dominant on lower slopes and flatlands (1, 2). Large mature specimens grow along the banks of the Little River, which flows into Indian Lake. Jack pine, is more abundant in the east where repeated fires have affected forest composition. The Phillipstown Ecological Reserve northeast of Coles Island is an example of typical lowland forest with of jack pine, black spruce, and red spruce.

Black spruce is rare in the adjacent Aukpaque Ecodistrict, but prevails on the acidic, poorly drained upland soils (3) and numerous bogs (3b) of this ecodistrict. The Acadia Forest Experiment Station north of Indian Lake contains an excellent example of upland black spruce, whereas the marsh at Northeast Branch Long Creek supports a representative bog black spruce community.

The few forest communities with sugar maple, yellow birch, and beech (4,7, 8) are restricted to higher elevation sites bordering the Anagance Ecodistrict to the south and the Bantalor Ecodistrict to the north. Bronson Ridge near Shipman is a notable exception.

The ecodistrict's unusually warm climate has encouraged the growth of tree species usually associated with more southerly regions. The resultant oak, green ash, butternut, and silver maple are especially prevalent on rich Interval soils (7b).

Sites at low elevation with infrequent flooding often display sugar maple, red maple, basswood, ironwood, white ash, and red oak, whereas the sandier shorelines are dominated by red oak and white ash. Cox Point Peninsula on the cobbly north shore of Grand Lake demonstrates several of these elements: its forest hosts cedar, red oak, red maple, silver maple, and hemlock.

Although this ecodistrict hosts a diversity of tree species and stand types, harvesting and agriculture have considerably altered the original forest, resulting in widespread tracts of red maple, grey birch, white birch, and trembling aspen, with scattered spruce and fir.

In addition to its diversity of tree species, the Maquapit Ecodistrict encompasses a variety of habitat features associated with shoreline and lowlands. For example, the Pickerel Pond Nature Preserve northeast of Scotchtown includes a sandspit, marshes with wild rice and amphibian habitat, plus a forest a black spruce, silver maple, bur oak, red maple, and large red oak. The unusual halberd-leaved tearthumb also occurs here.

Other significant plants occur across the ecodistrict: starved panic grass in Lakeside Provincial Park, buttonbush in the Grand Lake Meadows, pentagon dodder at Grand Lake, and Massachussetts fern at Princess Park.

The Jemseg River is seen here as a narrow band in the centre of the photograph, joining Maquapit Lake and Grand Lake. In the distance, the Saint John River flows toward the observer, past Gilbert Island.

The Portobello Creek Floodplain area west of French Lake harbours a truly remarkable grove of mature and massive red oaks. The area's most outstanding feature, is its extensive wetlands that contain crucial habitat for breeding ducks and migratory waterfowl. Over 250 bird species have been sighted in these marshes, along with 35 of the roughly 55 species of terrestrial mammals in the province.

Grand Lake also is a prime birding spot for many uncommon species, including black tern. Grand Lake Meadows, west of the lake, straddle both this and the adjoining Aukpaque Ecodistrict, and represent one of the most important bird habitat areas in the Maritimes. The meadows are used heavily by inland waterfowl during spring migration and host several breeding species of ducks each summer.

Settlement and Land Use

The Maquapit Ecodistrict lies within traditional Maliseet territory and was used regularly before the arrival of Europeans. It possessed marshes, lakes, and rivers with abundant fish, waterfowl, wild rice and other food sources, and also lay along major native portage routes between the Saint John River, the Miramichi River, and the Northumberland coast. Archaeologists have uncovered numerous burial sites, encampments, and other evidence of habitation dating back at least 4000 years. One site suggests an aboriginal presence as long as 9000 years ago.

The earliest Europeans arrived in the ecodistrict sometime in the middle to late 1600s and, over time, settled the shores of Grand Lake, Washademoak Lake, the Jemseg River, and other places that were favourable for farming. Logging and fishing were the other primary occupations. In addition, shipbuilding took place in Cumberland Bay and Douglas Harbour, and at Cambridge Narrows.

Washademoak Lake formed part of a crucial French communication route between the forts at Québec City and Beauséjour. After messengers from Québec had navigated the Saint John River, they paddled up Washademoak Lake to the Canaan River and from there portaged overland to the North River, which led to the Petitcodiac River and, hence, to Fort Beauséjour at the head of Cumberland Bay.

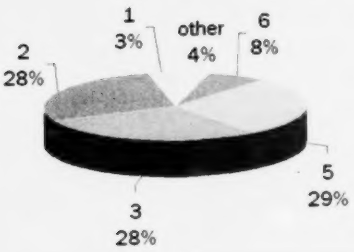
Mixed farming takes place here on the better soils. Since the early 1800s however, the main socioeconomic base of this ecodistrict, has been coal mining. The first coal shipment left for Boston in 1630s and represented the modest beginnings of what has become almost 300 years of continuous coal removal. Large-scale production began after the railroads reached the coalfields in the early 1900s. Although coal was excavated all along the north shore of Grand Lake, the largest operations lay near Minto. The ecodistrict's significance as a coal-mining centre is reflected in its place names, such as Coal Creek, Cumberland Point, and Newcastle Stream.

7.2. Maquapit Ecodistrict at a Glance

Ecoregion: Grand Lake Lowlands
Area: 209, 388 ha
Average elevation above sea level: 53 m
Average May–September precipitation: 425–450 mm
Average annual degree-days above 5°C: 1700–1800

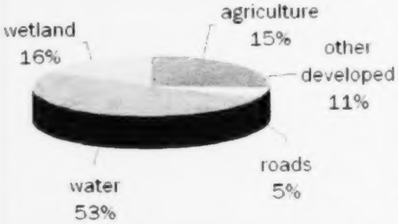
76% of Maquapit Ecodistrict has forest cover

ecosite coverage of forest area



24% of Maquapit Ecodistrict is not forested

uses of non-forest area



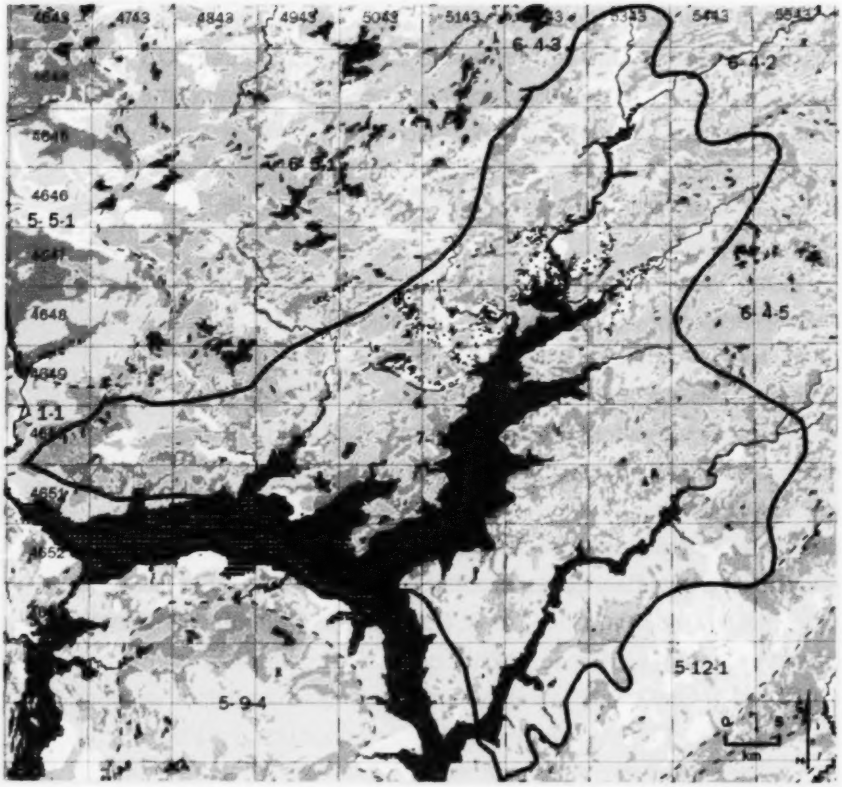
Ecosite map legend

ecosite

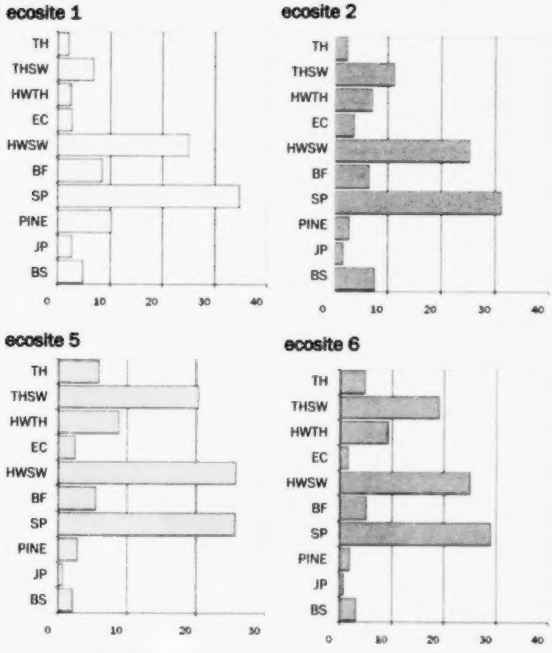
- 1
- ■ 2
- ▨ 3
- 4
- ▨ 5
- ▨ 6
- 7
- ▨ 8

ecosite modifiers

- c (calcareous)
- ■ o (organic)
- ☰ f (periodically flooded)
- ☐ h (high elevation)
- m (mining debris)
- ■ water


4643
4743
4843
4943
5043
5143
5343
5443
5543
6-4-3
6-4-2
4644
4645
6-5-1
4646
5-5-1
4647
4648
6-4-5
4649
1-1
4650
4651
4652
5-12-1
5-9-4
0
5
km

Percent cover of forest stand types by ecosite



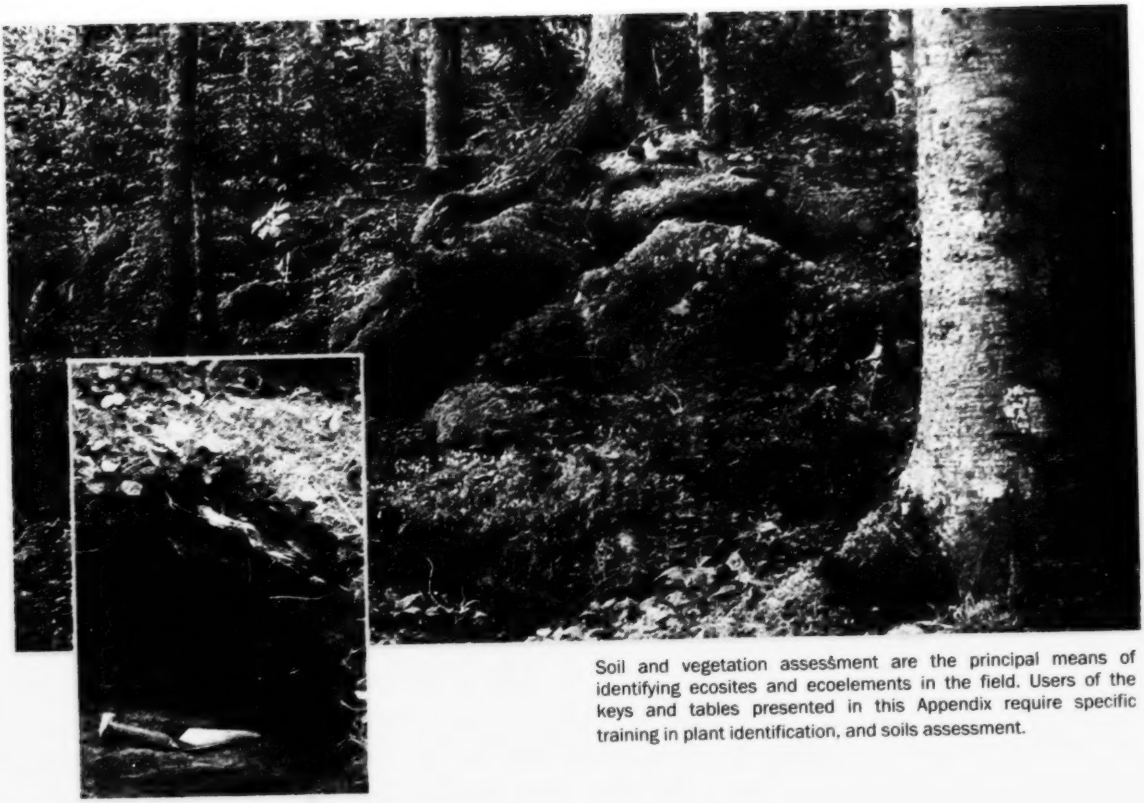
Vertical axis: BS–black spruce; JP jack pine; PINE–white pine; SP–white spruce; BF–balsam fir; HWSW–intolerant hardwood and softwood species; EC–eastern white cedar; HWTH–intolerant hardwood and tolerant hardwood species; THSW–tolerant hardwood with softwood species; TH–tolerant hardwood species. **Horizontal axis**: percent cover.

Epilogue

This introduction to ecological land classification (ELC) for New Brunswick has provided the reader with the means to recognize, describe and, to interpret patterns of climate topography and soils, especially as these influence aspects of the natural patterns of occurrence of plants and animals at various geographic scales. It was further explained that, in many ways, the current landscape and its associated communities and species are a product of physical and biological events that extend far back in time, prior to our earliest history in this region. Finally, it was noted that natural and human disturbances also affect the distribution of species and ecosystems in the present day, typically by generating favourable or adverse environmental conditions for plant and animals, due to their various adaptive traits.

The great 20th century American wildlife ecologist and forester Aldo Leopold wrote an essay in the 1940s entitled "The Land Ethic", in which he contrasted "man the conqueror of the land" with "man the just plain biotic citizen". Ecological land classification is both a perspective and a tool that assists us to be good biotic citizens and to be better stewards of the land.

Leopold is often further quoted, in reference to natural resource management, as saying: "The first rule of intelligent tinkering is to keep all the parts". Sound environmental stewardship is, at its most basic level, an exercise in keeping all the parts. This advice challenges us to extend our appreciation of forests and wetlands beyond those creatures that we know well, to include the full richness and diversity of living and non-living life forms that are represented by the variety of species, ecosystems and landscapes found in New Brunswick. We hope this exploration of ecological land classification has contributed something toward this goal.



Soil and vegetation assessment are the principal means of identifying ecosites and ecoelements in the field. Users of the keys and tables presented in this Appendix require specific training in plant identification, and soils assessment.

Appendix 1

Ecosites and Ecoelements

The New Brunswick Ecological Land Classification System described thus far has provided us with general information about areas that are thousands of hectares in size. In this chapter, the focus becomes very specific and fine-scale. Readers are introduced to some specific tools for classifying forest land in the field. This chapter is focused on the forest and thus it doesn't describe how to classify wetlands.

Ecosites are sub-divisions of the New Brunswick Ecological Land Classification system that encompass enduring features at the scale of a landform or part of a landform. Ridgetops, hillsides, and eskers are examples of landforms typically associated with ecosites. The relatively fine scale of ecosites means that they are recognizable from a high vantage point such as a low-flying aircraft, rather than from within a forest stand. Ecosites are generally uniform from the standpoint of moisture and nutrient regime, and of topoclimate.

At the ecoelement level of classification we discern the fine-scale ecological differences of soil moisture and nutrient condition, topoclimate, and the associated plant species composition.

Ecoelements are uniform with respect to ecosystem processes of growth and nutrient cycling, as well as their associated plant communities. An ecoelement is identified on the ground by observing the presence of plant indicator species that indicate soil nutrient conditions, as well as soil features including moisture regime, stoniness, and soil parent material type (see field survey methods at the end of chapter).

A user of ecosite maps will find that a single ecosite map polygon will generally be made up of the ecoelement for which it is named. Mapped ecosite polygons frequently encompasses additional portions of other ecoelements. For example, small wet spots or seeps may occur within an area that is mapped as predominantly well-drained. Or, conversely, we can find small, dry promontories on a primarily wet, swampy ecosite. These are examples of ecoelement diversity within ecosites.

In other words, ecosites are identified through mapping and are "complex" map units, while ecoelements are the basic units of both the ecosite and ecoelement levels of ELC. Both ecosites and ecoelements are named and numbered according to the 8 basic edatopic grid types first introduced in Chapter 5.

Purpose of Ecosite Maps and Ecoelement Keys

The ecosite and ecoelement levels of classification were conceived and developed for use in the assessment and management of forest lands.

The identity of an ecosite or an ecoelement in the context of an ecoregion can suggest, for example, what level of productivity in terms of tree growth may be expected. This information is important for a timber resource manager to help to maximize fibre growth rate and to make decisions on where to carry out silviculture. It is also possible to assess what vegetation might be considered the most natural forest condition for a site, given the character of its landform, its soil attributes. Maintaining a natural forest cover is of critical importance for maintenance of biodiversity, and ecosite maps, along with information about the frequency of forest stand types by ecosite and ecodistrict is presented diagrammatically in chapters 7 through 13.

Naming of Ecosites and Variants

In addition to the 8 basic ecosite templates, variants of the ecosites have been identified, where the two gradients of moisture and nutrients/topoclimate are insufficient to adequately give a full description of the site.

The suffix “s” is affixed to ecosites 1 and 2 when the slope is exceedingly strong. Extreme steepness of slope can contribute to very rapid drainage, or to intensified microclimatic effects.

The suffix “c” is assigned to sites that occur on soils derived from weathering of moderately to very calcareous rocks. Other factors being equal, increasing calcareousness of the soil parent material is correlated with higher soil pH and better overall nutrition for trees, leading to higher rates of growth and nutrient cycling.

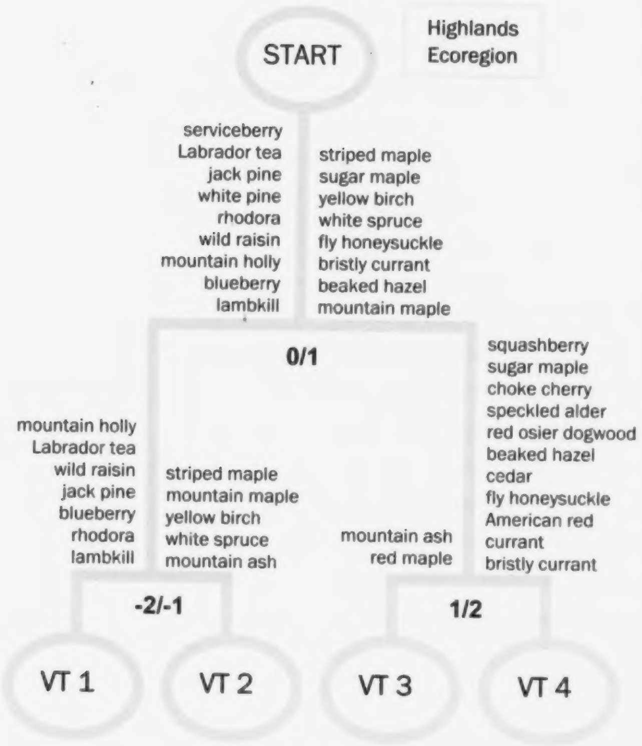
The suffix “h” is assigned to unusually high-elevation occurrences of ecosites 5 and 2. In both instances, the “h” describes predominantly coniferous sites that occur at high elevation in environments that are subalpine in character.

The suffix “o” is assigned to areas where peatlands are a prominent landscape feature, and “f”, describes bottomland sites on river floodplains and salt marshes (note, however, that ecosite maps do not reliably identify all salt marshes in the province).

Field Identification And Classification Of Ecoelements

While ecosites have been mapped across the area of the province, ecoelements are identified in the field from keys prepared for this purpose. Maps, however, will provide a starting point, as ecosites are named for their predominant ecoelement. It will often be necessary verify these attributes in the field. The following section provides a procedure for identifying ecoelements in the field that is supported by number of keys and tables designed for field assessments.

Field verification typically begins in the office with examination of aerial photographs of the site of interest and surrounding area to delineate possible ecosite variation. In most instances, ecological variation will be visible on the photographs, in terms of ruggedness of topography, and corresponding variation in vegetation composition. Fine scale topographic and soil maps may also be helpful. The photos can then be used to subdivide the landscape into relatively homogeneous units for survey purposes. At least one sample plot should be established in each of these subdivisions. Generally, a higher number of ground sample plots are assigned to subdivisions that account for a greater percentage of the geographic area, although the exact details of sampling methodology are dependent on the objective of the survey.


START
Highlands Ecoregion
serviceberry
Labrador tea
jack pine
white pine
rhodora
wild raisin
mountain holly
blueberry
lambkill
striped maple
sugar maple
yellow birch
white spruce
fly honeysuckle
bristly currant
beaked hazel
mountain maple
0/1
mountain holly
Labrador tea
wild raisin
jack pine
blueberry
rhodora
lambkill
striped maple
mountain maple
yellow birch
white spruce
mountain ash
mountain ash
red maple
squashberry
sugar maple
choke cherry
speckled alder
red osier dogwood
beaked hazel
cedar
fly honeysuckle
American red currant
bristly currant
-2/-1
1/2
VT 1
VT 2
VT 3
VT 4

At each sample plot, the Vegetation Type and the Soil Type are determined.

Determining Vegetation Type

Indicator species are plant species whose range of ecological tolerances is known and whose presence (either singly or in association with other indicators) suggests a relatively narrow range of soil status with respect to nutrient availability. Keys presented here use the concept of indicator species to guide the user to identify a Vegetation Type, which is an expression of nutrient status with four possible values, from 1 (poor) to 4 (rich). Three different Vegetation Type Keys were developed for the three groupings of ecoregion within which the relationships between plant indicators and soil conditions appear to be consistent.

How to use Vegetation Type Keys

First determine what ecoregion you are in, and select the appropriate key. Mark a circular plot of approximately 450 square metres (11.3 metre radius) on an area representative of the overall site condition. Assess the presence or absence of the species listed at the first division of the vegetation type key within the plot. For each species listed on the left side of the division, score -1; for each species on the right, +1. When no more of the species listed are found, the scores are summed and the sum is compared with the numbers, separated by a slash, provided below the division. If the sum is equal to or greater than the number on the right, proceed right. If it is less than or equal to the number on the left, proceed left. Subsequent divisions are assessed in the same way until an endpoint Vegetation Type is reached.

Field Sampling and Determination of Soil Type

A soil type is ecological classification unit for upland soils that is uniform with regard to soil moisture regime, and lithological composition of the soil parent material. An assumption built into the concept of soil types is that soil moisture regime is the primary determinant of growth and nutrient cycling, and that a secondary but still important determinant is the lithology of the soil parent material (where this affects soil acidity and nutrient status).

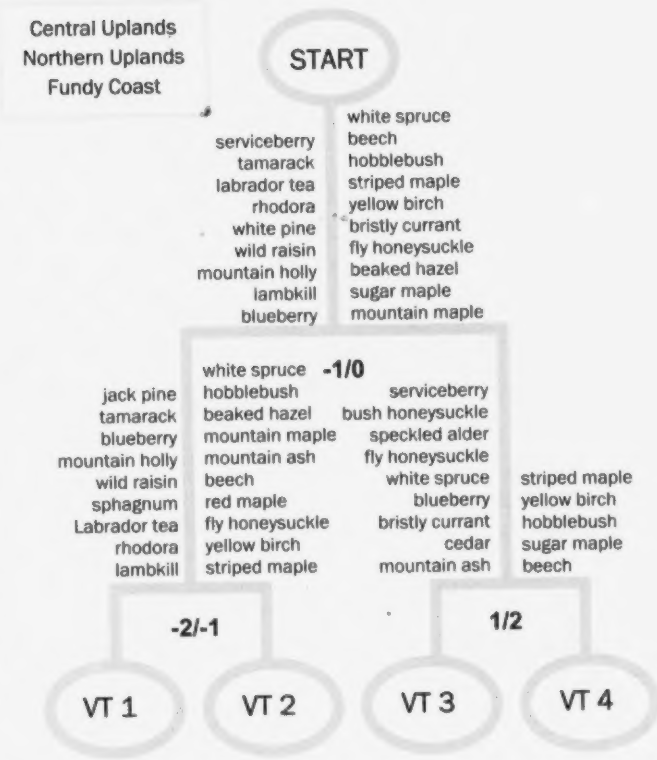
Soil Moisture Regime describes the extent to which moisture is removed from the soil in relation to the supply. It is determined in the field by referring to the soil moisture regime table.

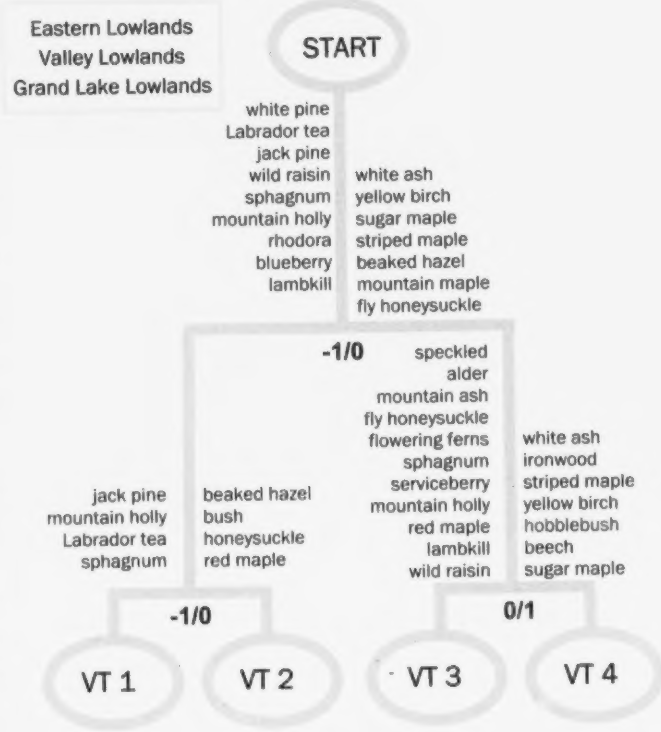
The source of precipitation is an important factor in the determination of soil moisture regime. Seepage is moisture that arrives at a site by downward flow from higher points on the landscape. Seepage may be greater on landforms that have a compact, fine textured soil horizon below the immediate rooting zone, or on shallow soils that lie above an impermeable layer of bedrock. Sites where seepage occurs will have more available soil moisture than sites where precipitation is the only source of moisture.

Because the amount of moisture in the soil is a function of recent past weather, it is important to be aware of the characteristics of a soil pit that indicate moisture regime. For instance, moist or wet soils may appear dry after prolonged periods of fair weather, and dry soils may seem moist after a rainfall or during the early spring. Soils that have a "fresh" or "dry" soil moisture regime will tend to have very brightly coloured soil horizons–typically a whitish "A" horizon, and a bright rusty brown or chocolate brown upper "B" horizon beneath the "A". As moisture regime becomes progressively wetter, the colours of the soil profile become more dull and grayish, starting at the bottom of the pit and increasing gray towards the soil surface as soil moisture regime becomes wetter.

Soils that are flooded for much of the year may show "mottles" of gray or reddish colour that contrast with the predominant colour of the horizon. A compact, fine-textured soil horizon or impermeable bedrock layer will prevent or impede infiltration of water below the reach of the roots.

Just as important as assessing soil profile character is assessment of the lay of the land, or the extent to which a site may be moisture shedding or moisture receiving. If a site is crested, flat, or slightly funnel-shaped; if it is at the toe of a slope or


Central Uplands
Northern Uplands
Fundy Coast
START
serviceberry
tamarack
labrador tea
rhodora
white pine
wild raisin
mountain holly
lambkill
blueberry
white spruce
beech
hobblebush
striped maple
yellow birch
bristly currant
fly honeysuckle
beaked hazel
sugar maple
mountain maple
-1/0
jack pine
tamarack
blueberry
mountain holly
wild raisin
sphagnum
Labrador tea
rhodora
lambkill
white spruce
hobblebush
beaked hazel
mountain maple
mountain ash
beech
red maple
fly honeysuckle
yellow birch
striped maple
serviceberry
bush honeysuckle
speckled alder
fly honeysuckle
white spruce
blueberry
bristly currant
cedar
mountain ash
striped maple
yellow birch
hobblebush
sugar maple
beech
-2/-1
1/2
VT 1
VT 2
VT 3
VT 4


Eastern Lowlands
Valley Lowlands
Grand Lake Lowlands
START
white pine
Labrador tea
jack pine
wild raisin
sphagnum
mountain holly
rhodora
blueberry
lambkill
white ash
yellow birch
sugar maple
striped maple
beaked hazel
mountain maple
fly honeysuckle
-1/0
speckled alder
mountain ash
fly honeysuckle
flowering ferns
sphagnum
serviceberry
mountain holly
red maple
lambkill
wild raisin
white ash
ironwood
striped maple
yellow birch
hobblebush
beech
sugar maple
jack pine
mountain holly
Labrador tea
sphagnum
beaked hazel
bush honeysuckle
red maple
-1/0
0/1
VT 1
VT 2
VT 3
VT 4

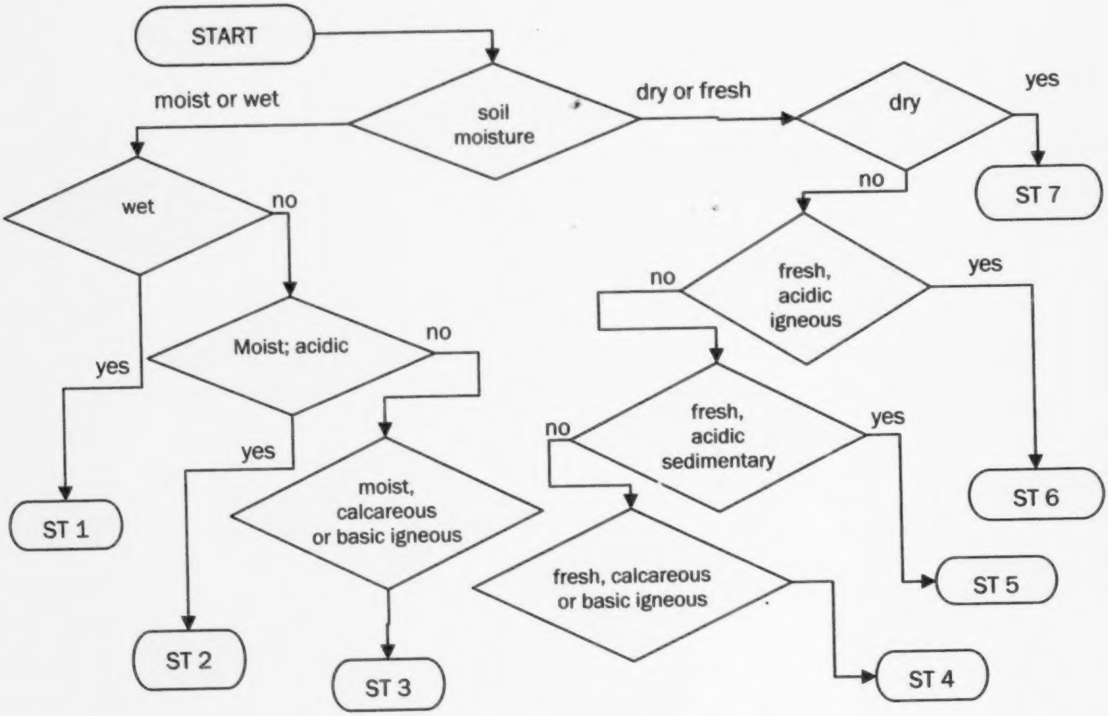
Moisture Regime Assessment Guide

moisture regime	defining characteristics		field recognition characteristics				
	description	primary water source	slope position	texture	drainage	available water storage capacity	slope gradient
dry	water removed rapidly in relation to supply; soil is moist for a short time after precipitation	precipitation	water shedding	coarse texture; loamy sand to sand; or > 80% coarse fragments between 30cm and 2m depth	rapid	low	may be steep
fresh	water removed somewhat slowly in relation to supply; soil may remain moist for a significant but sometimes short period of the year. Available soil moisture reflects recent weather events.	precipitation in medium to fine-textured soils or slight seepage in coarse-textured soils	upper to lower slopes	medium to fine texture; few coarse fragments; may be stonier or coarser with some seepage input	good to moderately good	moderate	moderately sloping
moist	water removed slowly enough to keep the soil wet for a significant part of the growing season; some soil mottling and seepage	precipitation and seepage	lower slopes or coves; receiving situations	variable depending on seepage	moderately good to imperfect	variable depending on seepage	slightly sloping or level
wet	water removed slowly enough to keep the soil wet for most of the growing season; permanent seepage; mottling and gleying	seepage or permanent water table	lower slopes; level or depressions	variable depending on seepage	poor or very poor	variable depending on seepage	flat

This soil moisture regime assessment guide is recommended for those who have had training in soil assessment.

at the slope's crest will influence the soil moisture regime.

As discussed in Chapter 3, soil texture refers to the percent composition of sand, silt, and clay particles. Keys are also provided to guide field assessment of soil texture. Coarse soils have a relatively high percentage of sand; fine textured soils have a relatively high percentage of silt and/or clay. Coarse textured soils have poor moisture-holding capacity relative to medium and fine


START
soil moisture
moist or wet
dry or fresh
dry
yes
ST 7
no
wet
no
fresh, acidic igneous
no
yes
Moist; acidic
no
yes
ST 6
fresh, acidic sedimentary
no
yes
yes
ST 1
moist, calcareous or basic igneous
fresh, calcareous or basic igneous
ST 5
ST 2
ST 3
ST 4

Soil Type Key.

When conducting a soil type assessment, a soil pit of at least 90 centimetres depth is dug and pebbles are collected from each size- and shape-class until the sample is considered representative of the pit. Lithology is best determined from a "fresh", unweathered rock surface. Use a rock hammer to crack sampled pebbles to expose unweathered surfaces (safety glasses are needed). A solution of 10% dilute hydrochloric acid is applied to an unweathered surface to determine the calcite content of calcareous rocks (avoid getting acid on clothing). To be classified as calcareous, the percentage of calcareous pebbles in a pit must be at least 30%. To be classified as basic igneous, the percentage of basic igneous pebbles in a pit must be at least 50%.

textured soils.

Coarse fragment content is an important consideration in assessment of soil moisture regime. Gravel, cobbles, stones and boulders occupy rooting space and preclude water storage. When bedrock is fractured and permeable to water, sites with bedrock near the surface may have dry moisture regimes.

Before assessing the geological origin of rock types in a soil pit, surveyors should already have familiarized themselves with local geology by various means at his or her disposal. These include: asking a geologist or soil scientist; using maps such as the *Forest Soils of New Brunswick*, regolith system maps, and/or bedrock geology maps; and examination of reference bedrock outcrops where they are well-exposed, such as road-cuts.

ST–VT grid and the edatopic grid

Once the vegetation type and soil type have been determined, the ST-VT grid for each ecoregion is used to determine the ecoelement classification of the site. Note the similarity between the ST-VT grid and the generalized edatopic grid depicted in Chapter 5. Due to the influence of precipitation on moisture regime, two ST–VT grids are presented here which correspond to different precipitation levels characteristic of ecoregion groupings.

Highlands, Central Uplands, and Fundy Ecoregions

Soil Type	Vegetation Type			
	VT 1	VT 2	VT 3	VT 4
Dry	1	4	4	8
Fresh, acidic igneous	2	2	5	7
Fresh, acidic sedimentary	2	5	5	7
Fresh, calcareous or basic igneous	2C	5C	5C	7C
Moist, calcareous or basic igneous	2C	5C	5C	7C
Moist, acidic	3	2	5	6
Wet	3	3	6	6

ST-Vt grid for the Highlands, Central Uplands, and Fundy Ecoregions. Numbers in the grid squares indicate the ecoelement associated with Soil Type and Vegetation Type combination.

Forest growth and yield

Ecosites and the edatopic grid is a convenient template for testing our ideas on rates of growth and yield. Forest productivity is not the same everywhere, just as some spots in our gardens are suitable for growing vegetables or flowers, while others will only support the growth of hardy weeds. The edatopic grid shown here is a graphical demonstration of a working hypothesis of the growth of managed, fully stocked stands relative to the edatopic grid.

On dry, moisture shedding sites (ecosites 4 and 8) in dry ecoregions, tree growth may be negatively affected during most years because of a lack of moisture in the soil. The vegetation itself will also have an important effect on soil moisture, due to the significant drain on soil moisture that occurs during plant growth. Plant foliage releases moisture into the air through evapotranspiration. The amount of water drawn through the roots, shoots, and eventually the leaves would be greater for a large amount of foliar biomass than for a smaller amount. The expected growth pattern over the life of a forest stand might follow the growth curve as outlined for ecosites 4 and 8 below: While trees are small, growth can proceed at its maximum rate; but as they gain roots and foliar biomass, their growth will strip the soil of its moisture on these dry, stony sites before the end of the growing season, and growth will decline as the trees mature relative to sites with more plentiful moisture.

On poor ecosites 1, 2, and 3, high soil acidity and slow nutrient cycling lead to conditions where growth is relatively slow due to a lack of nutrients, especially nitrogen. While all three conditions might be expected to perform less well than ecosites 5 and 7, where conditions are closer to optimal, ecosites 1 and 3 have moisture problems to contend with as well (too dry, and too wet respectively). Many of the same wetland forming process described in chapter 5 that lead to slow decomposition and accumulation of organic matter are active on Ecosite 3, and growth rate is normally quite low. Nevertheless, many natural stands on ecosite 3 support high volumes of high quality black spruce, though those high volumes normally take many years to develop.

On wet ecosite 6, there is adequate soil nutrition to support rapid tree growth, but excessive moisture may be a problem. Excessive moisture can lead to low oxygen levels in the soil, slow nutrient cycling, and poor growth performance. Complete removal of the overstory when harvesting on these moist sites often causes the water table to rise, creating slow-growing conditions over the short term for the young trees left behind, until, after the passage of a number of seasons, sufficient foliar and root biomass develops to "dry out the site", and leading to higher growth rates reflective of good nutrient status.

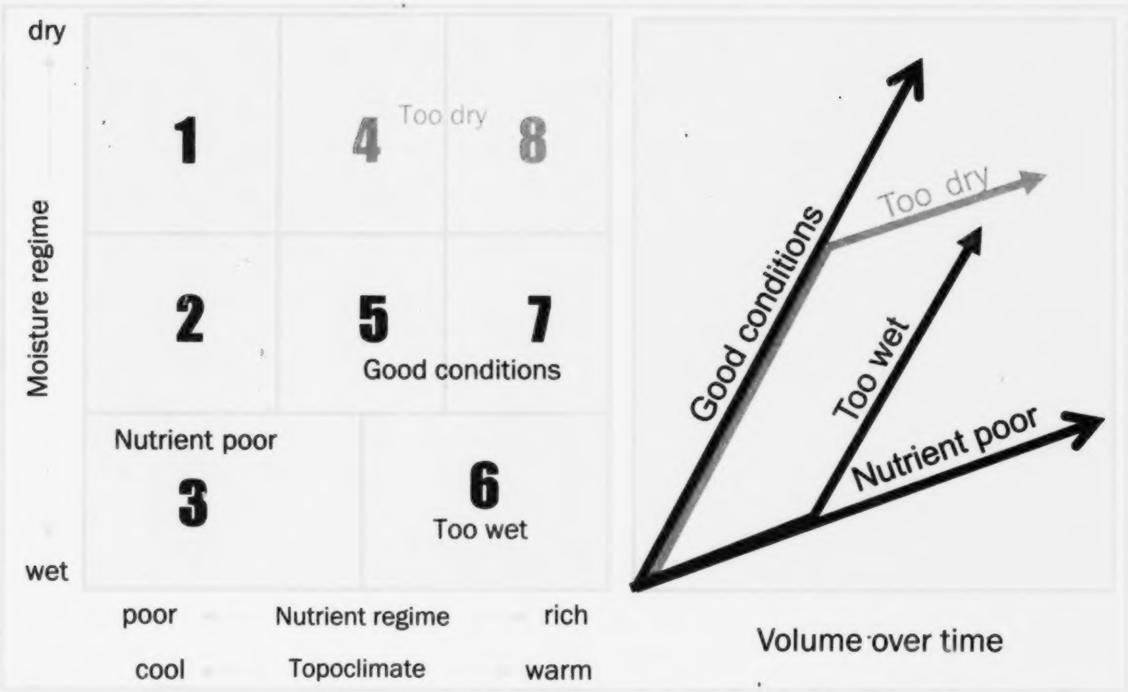
Northern Uplands, Grand Lake Lowlands, Eastern Lowlands, and Valley Lowlands Ecoregions

Soil Type	Vegetation Type			
	VT 1	VT 2	VT 3	VT 4
Dry	1	4	4	8
Fresh, acidic igneous	1	4	8	7
Fresh, acidic sedimentary	2	2	5	7
Fresh, calcareous or basic igneous	2C	5C	5C	7C
Moist, calcareous or basic igneous	2C	5C	5C	7C
Moist, acidic	3	2	5	6
Wet	3	3	6	6

ST-Vt grid for the Northern Uplands, Grand Lake Lowlands, Eastern Lowlands, and Valley Lowlands Ecoregions. Numbers in the grid squares indicate the ecoelement associated with each Soil Type and Vegetation Type combination.

Conclusion

In concluding this chapter, we briefly consider the adequacy of Ecological land classification, as a representation of ecological reality. This model has been used here to describe likely scenarios of forest growth and yield, and to describe forest community tree species composition for the purposes of conserving their diversity in the various regions of the province.


dry
Moisture regime
wet
1
4
Too dry
8
2
5
7
Good conditions
Nutrient poor
3
6
Too wet
poor
Nutrient regime
rich
cool
Topoclimate
warm
Good conditions
Too dry
Too wet
Nutrient poor
Volume over time

A simple model relating stand growth rates (right figure) to the edatopic grid of ecosites (left figure). See text for explanation. The growth patterns described here are based on a hypothesis that has received limited testing. It is intended to provide a rough guide for site selection and classification.

Growth and yield and species selection models presented in this chapter reflect current knowledge and assumptions about how things work, and it is likely that we will reach a point where our limited understanding is confounded by real-world complexity, and will need to be re-cast or further elaborated.

Lastly, it is important that we acknowledge the uniqueness at some level of every landscape, landform, and site as we go about classifying them. At least, we should be open to the possibility of their uniqueness. By continuing to question and scrutinize the theory and practice of ecological land classification we might provoke new insights and create new applications not known at present.

Appendix 2

Tree Species Selection Tables

We have seen how the ecosite template may be used as a guide for expected forest yield on various landscapes. The template may also be used to generate hypotheses on what species would have formed the pre-settlement forest at a given site, given the context of the ecoregion and the ecosite conditions. While it is difficult to say with certainty what species would be part of a "natural, pre-settlement" forest today in any site condition, we can test or modify our hypothesis where historic field data, such as land grant surveys, are available. Final determinations of "what tree species to promote where" depend on the objectives of management. Where conservation of biodiversity is an objective, significant efforts to reconstruct pre-colonial forest environments are needed.

The tables on the pages that follow are derived from ground survey data collected during the 1980s and 1990s, in mature forest stands. When used in conjunction with the ecodistrict-ecosite summary graphs (Chapters 7 through 13), as well as a critical reading of Chapter 4 (which describes trends of forest change in post-colonial time), plus some analysis of historical forest composition data, it is possible to generate recommendations and guidelines on what mix of tree species is natural or reflects past conditions in the ecoregions and ecosites of the province. Please note, the tables are applicable to upland forests only, and not seasonally-flooded bottomland forests.

It is also advisable to look to the future, and to speculate to the best of our ability on the possible future consequences of climate changes that are happening now. Theories about the possible trends of change in our region range from increasing broadleaved species and a reduction in conifers, to the exact opposite of this scenario. In other words, there is no scientific consensus on how the forest will change in response to climate change. There is similarly no easy or sure formula for identifying a desirable forest mosaic today that will mesh with climatic realities of the future. The best general approach may therefore be to promote or conserve a diversity of tree species at the stand level. This conservative approach will help to cultivate in the forest a future capacity for a broad array of possible ecosystem responses. Use of ecological land classification, as well as study of landscapes of the recent past, and study of forest change in the present time can help foresters and the society they serve to make appropriate and informed choices.

It is beyond the scope of this document to make recommendations for forest management that are more specific than what has been presented to this point. Such recommendations only make sense in the context of an agreed-to mixture of shared societal values, goals, and objectives that guide management.

How to use the tables

Tree species cover class for the forest community in the subject ecoregion is expressed as a range of percent basal area, and is denoted by the column in which the species is listed.

Tree species cover class codes appear as column headings:
dominant : species listed comprises greater than 50% of stand basal area
subdominant : species listed comprises 15 to 50% basal area
component : species listed comprises 5 to 14% basal area
present : species listed comprises 1 to 5% basal area

Frequency of occurrence of the species by cover class is denoted by the font with which a species code is displayed. It will also occur at lower cover classes, with equal or greater frequency, but is only listed in the column of its greatest cover class for the sake of brevity. In other words, if a species is listed as subdominant 15 to 50 percent of the time, then it is also likely occurs as component or present the rest of the time.

JP (upper case, bold): indicated cover class occurs more than 50% of the time
JP (upper case) : indicated cover class occurs 15 to 50% of the time
jp (lower case): indicated cover class occurs 5 to 14% of the time
jp (small font): indicated cover class occurs less than 5% of the time

	TREE SPECIES COVER CLASS			
FOREST COMMUNITY	DOMINANT (>50% BASAL AREA)	SUBDOMINANT (15 TO 50% BASAL AREA)	COMPONENT (5 TO 14% BASAL AREA)	PRESENT (<5% BASAL AREA)
BS	**BS**	BF jp wp	RM	ta rm ws ec yb rp tl sm

Example: Black spruce is a dominant species (greater than 50% basal area; denoted by column), in 50 to 100% of the plots surveyed (denoted by font).

Example: White pine is a subdominant species (comprising 15 to 50% of the basal area, as denoted by colunm), in 5 to 14% of the plots surveyed (denoted by font). Its frequency at lower abundance levels (i.e., when it is component or present) is as high or greater, but it is listed under this column only for the sake of brevity.

List of Abbreviations

BF	balsam fir
BS	black spruce
EC	eastern white cedar
EH	eastern hemlock
HWSW	intolerant hardwood and conifer species
HWTH	intolerant hardwood and tolerant hardwood species
IR	ironwood
JP	jack pine
OK	northern red oak
PINE	red or white pine
RM	red maple
RP	red pine
RS	red spruce
SM	sugar maple
SP	spruce species
TA	trembling aspen
TH	tolerant hardwood
THSW	tolerant hardwood and conifer species
TL	tamarack
WA	white ash
WB	white birch
WP	white pine
WS	white spruce
YB	yellow birch

Highlands

	TREE SPECIES COVER CLASS			
FOREST COMMUNITY	DOMINANT (>50% BASAL AREA)	SUBDOMINANT (15 TO 50% BASAL AREA)	COMPONENT (5 TO 14% BASAL AREA)	PRESENT (<5% BASAL AREA)
BS	**BS**	BF jp wp	RM	ta rm ws ec yb rp tl sm
JP	**JP**	RS	wp bf ws wb	ta rp rm ec tl
PINE	WP rp bs	WB jp rs	EC BF	WS RM ta
SP	RS BF ws	wb bs ec yb	RM wp sm	jp ta rp
BF	BF	WS BS wb yb rs	RM	**WB** wp ec ta
HWSW	WB RM	**BF** RM ws bs yb ec ta wp rs jp	sm	rp be
EC	**EC**	**BF** BS ws rs ta	wb	wp tl
HWTH	**WB**	YB sm	**BF** WS	
THSW	YB	**BF** SM RM WS wb	rs bs	ec be ta
TH	SM YB	RM bf be	WB WS	rs wp ec

Northern Uplands

	TREE SPECIES COVER CLASS			
FOREST COMMUNITY	DOMINANT (>50% BASAL AREA)	SUBDOMINANT (15 TO 50% BASAL AREA)	COMPONENT (5 TO 14% BASAL AREA)	PRESENT (<5% BASAL AREA)
BS	**BS**	BF ec wp	RM WB rs ws jp	rp ta sm be eh ok
JP	**JP** bs	rp	WP	WB RS bf
PINE	WP bs	RP BF ws ta ec rs jp	wb rm	yb sm
SP	RS ws	**BF** ec bs rm ta wb	wb sm	be jp eh ok
BF	**BF**	WS BS RM ec wb rs	YB SM wp	be ta wa eh
HWSW	tA rM	**BF** WB RM WS BS	SM YB	be eh rp jp
EC	**EC**	**BF** BS WS rs	RM YB WB WP SM	ta wa tl eh
HWTH	TA RM	WB SM	YB ws be	ec rs
THSW	sm bf	YB RM BE ws wb rs	EC bs	wp ta eh ok
TH	SM be	YB BF	WS wb	ec rs bs wp wa ta ok

Central Uplands

	TREE SPECIES COVER CLASS			
FOREST COMMUNITY	DOMINANT (>50% BASAL AREA)	SUBDOMINANT (15 TO 50% BASAL AREA)	COMPONENT (5 TO 14% BASAL AREA)	PRESENT (<5% BASAL AREA)
BS	**BS**	BF ec	WB RM yb ws rs	wp tl sm jp be ta
JP	-------------------------uncommon in ecoregion------------------------			
PINE	WP WS	jp rm ta	JP WB	**BF SM**
SP	RS WS	WB rm bs ec	YB ta sm	wp tl be eh jp wa rp
BF	**BF**	WS wb yb rs rm bs ec	sm	be ta tl wp
HWSW	rm ta wb	**BF RS** ws yb ec	sm bs be	wp tl eh jp rp
EC	**EC**	BF BS WS rs	rm wb yb	wp ta eh sm
HWTH	WB RM	sm ta	**BF** YB be ws	rs wp
THSW	sm	**BF YB** RM RS WB be ws	ec bs	ir wa eh wp ta
TH	SM be yb	rM	BF wb rs	WS bs wa ec ir

Fundy Coast

FOREST COMMUNITY	TREE SPECIES COVER CLASS			
	DOMINANT (>50% BASAL AREA)	SUBDOMINANT (15 TO 50% BASAL AREA)	COMPONENT (5 TO 14% BASAL AREA)	PRESENT (<5% BASAL AREA)
BS	**BS**	BF tl wb	RM rs wp	yb ir ta ws rp
JP	-------------------------uncommon in ecoregion------------------------			
PINE	-------------------------uncommon in ecoregion------------------------			
SP	**RS**	BF WB ec ws tl rm bs	yb	wp ta sm be
BF	**BF BS**	WB RS tl	ec rm yb ws	*wp*
HWSW	WB tl rm	BF RS ta yb bs ec	ws wp	sm be eh
EC	**EC**	RS WB BS bf rm	ws	YB tl wp ir
HWTH	WB RM	YB tA	RS BF WS ec tl	SM wp
THSW	YB	**RS WB** RM sm bf ec	be ws	
TH	**SM YB**	BE rm bf	RS	WB

Valley Lowlands

FOREST COMMUNITY	TREE SPECIES COVER CLASS			
	DOMINANT (>50% BASAL AREA)	SUBDOMINANT (15 TO 50% BASAL AREA)	COMPONENT (5 TO 14% BASAL AREA)	PRESENT (<5% BASAL AREA)
BS	**BS**	BF ec rm tl wp wb	ta	rs rp ws yb eh sm
JP	**JP** bs	RS WS bf rp tl ta	WP RM WB eh	ok
PINE	WP RP	RS RM wb bs	BF ws ta ec jp tl	sm yb ok eh wa
SP	RS ws	BF RM EC wb ta eh tl	YB wp	be sm wa rp jp bs ir
BF	BS	WS BS wb yb rs	YB sm tl bs wp eh	be wa ir
HWSW	ta rm wb	BF RS ec ws bs eh	YB wp tl	be sm wa ir rp jp ok
EC	**EC**	BF RS bs rm ws	WB ta yb eh tl	WP sm wa be ir
HWTH	WB TA rm	yb	BE BF SM ws	RS wp ec wa eh tl ir bs
THSW		SM BF RM RS YB BE wb ta ec	eh ws wa	IR wp bs tl ok rp
TH	SM BE	RM YB bf	RS wb ir wa	ta eh ws ec bs ok wp

Eastern Lowlands

FOREST	TREE SPECIES COVER CLASS			
	DOMINANT	SUBDOMINANT	COMPONENT	PRESENT
COMMUNITY	(>50% BASAL AREA)	(15 TO 50% BASAL AREA)	(5 TO 14% BASAL AREA)	(<5% BASAL AREA)
BS	**BS**	jp bf rm	WP TL ta ec rs wb	ws rp eh yb
JP	**JP** BS	rs	WS rm ta bf	WP WB tl rp
PINE	WP bs rs	ta rp jp bf	RM WB ws	tl ec eh
SP	RS ws	BF RM ta bs wp ec wb	tl yb jp eh	be sm rp
BF	BF	RM RS ec ws bs ta wb	wp sm be	YB tl wa ir jp rp ok
HWSW	TA rm	WB BF RS BS wp ec tl	yb jp	eh be sm rp ok wa
EC	**EC**	BF RS BS RM ws	wb eh ta wp	YB tl
HWTH	TA RM	WB	be sm yb rs	BF ws jp bs wa
THSW		RM RS BE YB BF SM wb ta bs	EH ws wp	ir jp tl wa ok
TH	SM rm be	YB rs wb	BF ta eh ws	ir wa ec bs

Grand Lake Lowlands

FOREST	TREE SPECIES COVER CLASS			
	DOMINANT	SUBDOMINANT	COMPONENT	PRESENT
COMMUNITY	(>50% BASAL AREA)	(15 TO 50% BASAL AREA)	(5 TO 14% BASAL AREA)	(<5% BASAL AREA)
BS	**BS**	bf rm tl wp jp	ec wb ta rs	ws jp sm
JP	**JP**	BS RS rp tl	TA ws	RM WP bf
PINE	WP rs rp	BS BF ws rm	WB TA TL ok	eh jp sm
SP	RS ws	**BF** RM wb ec ta wp	TA TL eh bs yb	jp rp sm be wa ir ok
BF	BF	RM RS ws ec ta tl wb bs wp eh	TA	yb sm rp jp ok wa
HWSW	RM ta	BF WB RS ec eh bs tl	WP WS yb	be sm jp rp wa ir ok
EC	**EC**	BF RS RM ws eh tl ta	WP WB TA bs	yb sm ir wa be
HWTH	RM TA wb		sm yb	bf rs tl ir yb
THSW	be	RM BF SM TA WB yb ec rs bs eh	TA ws wp tl ir	ok jp rp wa
TH	SM RM	BE YB	WB RS ta bf	EH IR ws tl ok

Appendix 3: Species List

English	Latin	French
PLANTS		
Acadian quillwort	Isoetes acadiensis	Isoète acadien
Alder	Alnus sp.	Aulne
Alpine bilberry (bog blueberry)	Vaccinium uliginosum	Airelle des marécages
Alternate-leaved dogwood	Cornus alternifolia	Cornouiller à feuilles alternes
American mountain-ash	Sorbus americana	Sorbier d'Amérique (cormier)
American red currant	Ribes triste	Gadellier amer
Arctic sweet coltsfoot	Petasites frigidus	Pétasite palmé (pétasite hybride)
Arrow-grass	Triglochin sp.	Troscart
Ash	Fraxinus sp.	Frêne
Aspen	Populus sp.	Tremble
Atlantic manna grass	Glyceria obtusa	Glycérie
Awlwort	Subularia aquatica	Subulaire aquatique
Back's sedge	Carex backii	Carex de Back
Bake-apple (cloudberry)	Rubus chamaemorus	Ronce petit-mûrier (mûres blanches)
Balsam fir	Abies balsamea	Sapin baumier
Balsam poplar	Populus balsamifera	Peuplier baumier (liard)
Basswood (American linden)	Tilia americana	Tilleul d'Amérique (bois blanc)
Bathurst saltmarsh aster	Aster subulatus var. obtusifolius	Aster subulé
Beaked hazelnut	Corylus cornuta	Noisetier à long bec
Beech (American beech)	Fagus grandifolia	Hêtre à grandes feuilles (hêtre américain)
Bigelow's sedge	Carex bigelowii	Carex de Bigelow
Birch	Betula sp.	Bouleau
Black ash	Fraxinus nigra	Frêne noir
Black cherry	Prunus serotina	Cerisier Tardif
Black crowberry	Empetrum nigrum	Camarine noire (Graines à corbigeaux)
Black grass	Juncus gerardii	Jonc de Gérard
Black spruce	Picea mariana	Épinette noire
Black willow	Salix nigra	Saule noir
Bloodroot	Sanguinaria canadensis	Sanguinaire du Canada (sang-dragon)
Blue cohosh (papoose-root)	Caulophyllum thalictroides	Caulophylle faux-pigamon
Blue flag (iris)	Iris versicolor	Iris sauvage (clajeux)
Blueberry	Vaccinium sp.	Airelle (atocas)
Bluestem (broom or prairie beardgrass)	Schizachyrium scoparium	Schizachyrium à balais
Bog aster	Aster nemoralis	Aster des bois
Bog-rosemary	Andromeda polifolia	Andromède glauque
Braun's holly fern	Polystichum braunii	Polystic de Braun
Bristly club-moss	Lycopodium annotinum	Lycopode innovant
Bristly currant	Ribes lacustre	Groseillier sauvage
Broad-lipped twayblade	Listera convallarioides	Listère faux-muguet
Brunet's milk-vetch	Astragalus alpinus var. brunetianus	Astragale de Brunet
Bullhead-lily (beaver-root)	Nuphar variegata	Pied-de-cheval
Bunchberry	Cornus canadensis	Quatre-temps
Bur oak (mossy-cup oak)	Quercus macrocarpa	Chêne à gros fruits
Bush-honeysuckle	Diervilla lonicera	Dièreville chèvrefeuille (herbe bleue)
Bushy aster	Aster dumosus	Aster à feuilles cordées
Butternut	Juglans cinerea	Noyer cendré
Buttonbush	Cephalanthus occidentalis	Céphalanthe occidental (bois noir)
Calico aster	Aster lateriflorus	Aster latériflore
Calypso orchid	Calypso bulbosa	Calypso bulbeux
Canada violet	Viola canadensis	Violette du Canada
Canada yew (ground-hemlock)	Taxus canadensis	If du Canada (buis de sapin)
Cattail	Typha sp.	Quenoille (massette)
Choke cherry	Prunus virginiana	Cerisier à grappes
Christmas fern	Polystichum acrosticoides	Polystic faux-acrostiche
Cinnamon fern	Osmunda cinnamomea	Osmunde canelle
Clammy hedge-hyssop	Gratiola neglecta	Gratiole négligée
Climbing false buckwheat	Fallopia scandens	Renouée grimpante
Clinton's wood fern	Dryopteris clintoniana	Dryoptère de Clinton
Closed gentian	Gentiana linearis	Gentiane à feuilles linéaires
Closed-head sedge	Carex norvegica	Carex de Norvège
Cluster sanicle (yellow sanicle)	Sanicula odorata (Sanicula gregaria)	Sanicle grégaire
Coastal salt grass	Distichlis spicata	Distichlis dressé
Common lousewort (wood-betony)	Pedicularis canadensis	Pédiculaire du Canada
Common moonwort	Botrychium lunaria	Botryche lunaire
Common plantain (white-man's-foot)	Plantago major	Grand plantain
Common speedwell	Veronica officinalis	Thé d'Europe
Common wood-sorrel	Oxalis montana	Surette
Cotton-grass	Eriophorum sp.	Linaigrette
Curly-grass fern	Schizaea pusilla	Schizée naine
Cut-leafed toothwort	Cardamine concatenata	Dentaire laciniée

English	Latin	French
Divaricate rock-cress	Arabis xdivaricarpa	Arbette à fruits divariqués
Dogwood	Cornus sp.	Cornouiller
Dutchman's-breeches	Dicentra cucullaria	Dicentre à capuchon
Dwarf birch	Betula glandulosa	Bouleau glanduleux
Dwarf huckleberry	Gaylussacia dumosa	Gaylussaquier nain
Dwarf rattlesnake-plantain	Goodyera repens	Goodyérie rampante
Early saxifrage	Saxifraga virginiensis	Saxifrage de Virginie
Eastern hemlock	Tsuga canadensis	Pruche de l'Est
Eastern skunk cabbage	Symplocarpus foetidus	Symplocarpe fétide (Chou puant)
Eastern white cedar (cedar)	Thuja occidentalis	Cèdre de l'Est (thuya occidental)
Eel-grass	Zostera marina	Zostère marine
Elegant sedge (low northern sedge)	Carex concinna	Carex élégant
Elm	Ulmus sp.	Orme
Entire-leaved mountain avens	Dryas integrifolia	Dryade à huit pétales
Ericaceous shrubs, heath family	Ericaceae	Éricacées
Floating bladderwort	Utricularia radiata	Utriculaire
Flowering ferns	Osmunda sp.	Osmonde
Fly honeysuckle	Lonicera canadensis	Chèvrefeuille du Canada
Foamflower (false mitrewort)	Tiarella cordifolia	Tiarelle cordifoliée
Fragrant water-lily	Nymphaea odorata	Nénuphar blanc
Fringed violet	Viola sagittata (Viola fimbriatula)	Violette ciliée
Furbish's lousewort	Pedicularis furbishiae	Pédiculaire de Furbish
Giant mountain aster	Aster modestus	Aster
Giant rattlesnake-plantain	Goodyera oblongifolia	Goodyérie à feuilles oblongues
Glasswort (chicken-claws)	Salicornia europaea	Salicorne maritime (corail)
Glaucous meadow-grass (glaucous poa)	Poa glauca (Poa glaucantha)	Pâturin à fleurs glauques
Goldie's (or large) round-leaved orchid	Platanthera macrophylla	Habénaire orbiculaire de Goldie
Goldie's fern (Goldie's shield-fern)	Dryopteris goldiana	Dryoptère de Goldie
Goldthread	Coptis trifolia	Savoyane
Grapefern (moonwort)	Botrychium sp.	Botryche
Grasses (grass family)	Poaceae	Poacées
Grass-pink (calopogon)	Calopogon tuberosus	Calopogon tubéreux
Great water dock	Rumex orbiculatus	Rumex orbiculaire
Greater creeping rush	Juncus subtilis	Jonc délié
Green ash (red ash)	Fraxinus pennsylvanica	Frêne rouge
Green's rush	Juncus greenei	Jonc de Green
Grey birch	Betula populifolia	Bouleau gris
Gulf of St. Lawrence aster	Brachyactis ciliata subsp. laurentianus	Aster du Golfe St-Laurent
Halberd-leaved tearthumb	Persicaria arifolia (Polygonum arifolium)	Renouée à feuilles d'Arum
Hay-scented fern	Dennstaedtia punctilobula	Dennstaedte à lobules ponctués
Helleborine	Epipactis helleborine	Épipactis petit-hellébore
Hidden-scaled sedge (northeastern sedge)	Carex cryptolepis	Carex à écailles cachées
Highland rush (bog rush)	Juncus trifidus	Jonc trifide
Hobblebush	Viburnum lantanoides (Viburnum alnifolium)	Viorne à feuilles d'aulne (bois d'orignal)
Indian cucumber-root	Medeola virginiana	Concombre sauvage (médéole de Virginie)
Ironwood (American hop-hornbeam)	Ostrya virginiana	Ostryer de Virginie (bois dur, bois de fer)
Jack pine	Pinus banksiana	Pin gris
Labrador-tea	Rhododendron groenlandicum	Thé du Labrador
Lake sedge	Carex lacustris	Carex lacustre
Lapland buttercup	Ranunculus lapponicus	Renoncule de Lapponie
Large (or American) cranberry	Vaccinium macrocarpon	Airelle à gros fruits (gros atocas)
Large round-leaved orchid	Platanthera orbiculata	Habénaire à feuilles orbiculaires
Large-toothed aspen	Populus grandidentata	Peuplier à grandes dents
Leather-leaf	Chamaedaphne calyculata	Faux bleuets
Leatherwood	Dirca palustris	Bois de plomb
Lepidocarpate sedge	Carex viridula subsp. brachyrrhyncha	Carex lépidocarpé
Lesser bladderwort	Utricularia minor	Utriculaire mineure
Lichen (no common name)	Cladina terrae-novae	Lichen (pas de nom commun)
Little grapefern	Botrychium simplex	Botryche simple
Little shinleaf	Pyrola minor	Pyrole mineure
Livelong saxifrage	Saxifraga paniculata	Saxifrage aïzoon
Livid sedge	Carex livida	Carex livide
Low water-milfoil	Myriophyllum humile	Myriophylle
Lowbush blueberry	Vaccinium angustifolium	Airelle à feuilles étroites (bleuets)
Lungwort (a lichen)	Lobaria pulmonaria	Lichen pulmonaire
Maidenhair fern	Adiantum pedatum	Adiante pédalé (capillaire)
Maidenhair spleenwort	Asplenium trichomanes	Asplénie chevelue
Maple-leaved goosefoot	Chenopodium simplex (Chenopodium gigantospermum)	Chénopode simple
Massachussetts fern	Thelypteris simulata	Thélyptère simulatrice
Mayflower (trailing arbutus)	Epigaea repens	Épigée rampante (Fleur de mai)
Meadow-sweet	Spiraea alba	Thé du Canada (spirée)
Mealy (bird's-eye primrose)	Primula laurentiana (Primula farinosa)	Primevère farineuse
Mermaid-weed	Proserpinaca palustris	Proserpinie des marais
Methuselah's beard (lichen)	Usnea longissima	Barde de Methuselah (lichen)
Mingan moonwort	Botrychium minganense	Bortyche de Mingan
Moss (no common name)	Entodon brevisetus	Mousse (pas de nom commun)
Moss (no common name)	Splachnum pennsylvanicum	Mousse (pas de nom commun)

English	Latin	French
Mosses	Division Bryophyta, subdivision Musci	Mousses
Mountain cranberry (rock cranberry)	Vaccinium vitis-idaea	Berris (graines rouges)
Mountain maple	Acer spicatum	Érable à épis
Mountain valerian (swamp valerian)	Valeriana uliginosa	Valériane des vases
Mountain wood fern	Dryopteris campyloptera	Dryoptère à ailes recourbées
Mountain-fern moss	Hylocomium splendens	Hylocomie brillante
Mountain-holly	Nemopanthus mucronatus	Faux houx
Myrtle-leaved willow	Salix myrtillifolia	Saule à feuilles de myrtille
Naked mitrewort	Mitella nuda	Mitrelle nue
Native hop (American hop)	Humulus lupulus var. lupuloides	Houblon américain
Nodding fescue	Festuca subverticillata (Festuca obtusa)	Fétuque obtuse
Nodeweed (jointweed)	Polygonella articulata	Polygonelle articulée
Northern adder's tongue	Ophioglossum pusillum	Ophioglosse vulgaire
Northern bog aster	Aster borealis	Aster boréale
Northern comandra	Geocaulon lividum	Comandre livide
Northern red oak (red oak)	Quercus rubra	Chêne rouge
Northern wild-licorice	Galium kamtschaticum	Gaillet du Kamtschatka
Northern woodsia (alpine woodsia)	Woodsia alpina	Woodsie alpine
Nuttall's waterweed	Elodea nuttallii	Élodée de Nuttall
Oak	Quercus sp.	Chêne
Oakes' pondweed	Potamogeton oakesianus	Potamot d'Oakes
Orchid family	Orchidaceae	Orchidacées
Ox-eye	Heliopsis helianthoides	Héliopsis faux-hélianthe
Painted trillium	Trillium undulatum	Trille ondulé
Pale smartweed (willow-weed)	Persicaria lapathifolia (Polygonum lapathifolium)	Renouée à feuilles de Patience
Pale touch-me-not	Impatiens pallida	Impatiente pâle
Parker's pipewort	Eriocaulon parkeri	Ériocolon de Parker
Pentagon dodder	Cuscuta pentagona	Cuscute pentagonale
Pickerelweed	Pontederia cordata	Pontédérie cordée
Pin cherry	Prunus pensylvanica	Cerisier de Pennsylvanie (petit merisier)
Pine	Pinus sp.	Pin
Pine-drops	Pterospora andromedea	Ptérospore andromède
Pink lady's-slipper (stemless lady's-slipper)	Cypripedium acaule	Cypripède acaule (Sabot de la Vierge)
Pink pyrola (wintergreen)	Pyrola asarifolia	Pyrole à feuilles d'Asaret
Pipsissewa (Prince's pine)	Chimaphila umbellata	Chimaphile à ombelles (herbe à la clef)
Pitcher-plant	Sarracenia purpurea	Sarracénie pourpre
Plume moss	Ptilium crista-castrensis	Hypne plumeuse
Poplar	Populus sp.	Peuplier
Prickly (or wild) cucumber	Echinocystis lobata	Concombre grimpant
Prototype quillwort	Isoetes prototypus	Isoète
Purple milkwort (red milkwort)	Polygala sanguinea	Glaux rouge (Polygala sanguin)
Raspberry	Rubus sp.	Framboisier
Red cedar	Thuja plicata	Cèdre de l'Ouest (thuya de l'Ouest)
Red maple	Acer rubrum	Érable rouge
Red osier	Cornus sericea	Hart rouge
Red pine	Pinus resinosa	Pin rouge
Red spruce	Picea rubens	Épinette rouge
Red trillium (purple trillium)	Trillium erectum	Trille dressé
Rhodora	Rhododendron canadense	Rhododendron du Canada
Richardson's muhlenbergia (matted muhly)	Muhlenbergia richardsonis	Muhlenbergie de Richardson
River bulrush	Bolboschoenus fluviatilis (Scirpus fluvialis)	Scirpe fluviatile
Riverbank grape (wild grape)	Vitis riparia	Vigne des rivages
Robbins' spike-rush	Eleocharis robbinsii	Éléocharide
Rock spike-moss	Selaginella rupestris	Sélaginelle des rochers
Rocky Mountain goldenrod	Solidago multiradiata	Verge d'or
Round-leaved hepatica	Anemone americana (Hepatica americana)	Anémone d'Amérique
Rufous bulrush	Scirpus pendulus (Scirpus lineatus)	Scirpe
Saltmarsh aster	Aster subulatus	Aster subulé
Salt-meadow grass	Spartina patens	Musotte
Salt-water cord grass	Spartina alterniflora	Spartine alterniflore (herbe salée)
Schreber's moss	Pleurozium schreberi	Hypne de Schreber
Scotch lovage	Ligusticum scothicum	Livêche écossaise
Sea-grass (ditch-grass)	Ruppia maritima	Ruppie maritime
Sea-lavender	Limonium carolinianum	Lavande de mer
Sea-milkwort (saltwort)	Glaux maritima	Glaux maritime
Seaside pinweed	Lechea maritima	Léchéa intermédiaire maritime
Seaside plantain	Plantago maritima	Perce-pierre
Sedge	Carex sp.	Laiche
Sedge (no common name)	Carex josselynii	Carex (pas de nom commun)
Sedges, sedge family	Cyperaceae	Cyperacées
Seep leopardbane	Arnica lonchophylla	Arnica
Selkirk's violet (great-spurred violet)	Viola selkirkii	Violette de Selkirk
Sensitive fern	Onoclea sensibilis	Onoclée délicate
Serviceberry	Amelanchier sp.	Petites poires (poirier)
Sessile-leaved bellwort (wild oats)	Uvularia sessifolia	Uvulaire à feuille sessiles
Sheep laurel (lambkill)	Kalmia angustifolia	Crevard de moutons
Shining club-moss	Huperzia lucidula (Lycopolium lucidulum)	Lycopode brillant

English	Latin	French
Showy lady's-slipper	Cypripedium reginae	Cypripède royal
Showy orchis	Galearis spectabilis	Orchide admirable (orchis brillant)
Shrubby cinquefoil	Pentaphylloides floribunda (Potentilla fruticosa)	Potentille frutescente
Silky dogwood	Cornus amomum	Cornouiller oblique (cornouiller amome)
Silver maple	Acer saccharinum	Érable argenté
Skunk currant	Ribes glandulosum	Gadellier glanduleux
Slender panic grass	Panicum linearifolium	Panic à feuilles linéaires
Small cranberry (bog cranberry)	Vaccinium oxycoccus	Airelle canneberge
Small enchanter's-nightshade	Circaea alpina	Circée alpine
Small eyebright (Rand's eyebright)	Euphrasia randii	Euphraise de Rand
Small purple fringed orchid	Platanthera psycodes	Platanthère papillon (habénaire papillon)
Small round-leaved orchid	Amerorchis rotundifolia	Orchis à feuille ronde
Small-flowered anemone	Anemone parviflora	Anémone à petites fleurs
Small-flowered bitter-cress	Cardamine parviflora	Cardamine parviflore
Small-flowered gerardia	Agalinis paupercula	Gérardie appauvrie
Smooth aster	Aster laevis	Aster lisse
Smooth white oldfield aster	Aster racemosus (Aster vimineus var. subdumosus)	Aster subulé blanc
Smooth woodsia (cliff fern)	Woodsia glabella	Woodsie glabre
Smooth yellow violet	Viola pubescens	Violette pubescente
Snapdragon (or figwort) family	Scrophulariaceae	Scrophulariacées
Soapberry	Shepherdia canadensis	Shepherdie du Canada
Soft-stem bulrush	Schoenoplectus tabernaemontani (Scirpus validus)	Scirpe vigoureux
Southern twayblade	Listera australis	Listère australe
Speckled alder	Alnus incana	Aulne blanchâtre
Sphagnum moss	Sphagnum sp.	Sphaigne
Sphagnum moss (no common name)	Sphagnum austinii	Sphaigne (pas de nom commun)
Sphagnum moss (no common name)	Sphagnum imbricatum	Sphaigne (pas de nom commun)
Spike-rush	Eleocharis sp.	Éléocharide
Spreading millet grass	Milium effusum	Millet sauvage (millet diffus)
Spring-beauty	Claytonia caroliniana	Claytonie de Caroline
Spruce	Picea sp.	Épinette
St. Lawrence grapefern	Botrychium rugulosum	Botryche du St. Laurent
Starved panic grass	Panicum depauperatum (Dichanthelium depauperatum)	Panic appauvri
Striped maple (moosewood)	Acer pensylvanicum	Érable de Pennsylvanie (bois d'orignal)
Sugar maple (rock maple)	Acer saccharum	Érable à sucre
sundew	Drosera anglica	Rossolis d'Angleterre
Swamp fly honeysuckle	Lonicera oblongifolia	Chèvrefeuille à feuille oblongues
Swamp milkweed	Asclepias incarnata	Asclépiade incarnata
Swamp-pink (dragon's mouth)	Arethusa bulbosa	Aréthuse bulbeuse
Sweet flag	Acorus americanus	Belle-angélique
Sweet gale (meadow-fern)	Myrica gale	Myrique baumier (bois-sent-bon)
Sweet grass (Indian grass)	Hierochloë odorata	Foin d'odeur (herbe sainte)
Sweet viburnum (nannyberry)	Viburnum lentago	Viorne lentago (bourdaine)
Tall drop-seed	Sporobolus compositus (Sporobolus asper)	Sporobole
Tamarack (eastern larch)	Larix laricina	Mélèze laricin (mélèze d'Amérique)
Ten-rayed sunflower	Helianthus decapetalus	Hélianthe à dix rayons
Threadfoot (river-weed)	Podostemum ceratophyllum	Podostémon cératophylle
Threadleaf-pondweed	Stuckenia filiformis (Potamogeton filiformis)	Potamot filiforme
Tiger lily	Lilium lancifolium	Lis tigré (martagon)
Toad rush	Juncus bufonius	Jonc des crapauds
Trembling aspen	Populus tremuloides	Peuplier faux-tremble (tremble)
Trillium	Trillium sp.	Trille
Trout-lily (dog's-tooth-violet)	Erythronium americanum	Ail doux
Tuckerman's quillwort	Isoetes tuckermanii (var. borealis)	Isoète de Tuckerman
Tufted club-rush (deer's hair, deer grass)	Tricophorum cespitosum (Scirpus cespitosum)	Scirpe gazonnant
Twig-rush (smooth saw-grass)	Cladium mariscoides	Cladium faux-mariscus
Twining screwstem	Bartonia paniculata	Bartonie paniculé
Violet	Viola sp.	Violette
Virginia mountain-mint	Pycnanthemum virginianum	Pycnanthème verticillé
Water-parsnip	Sium suave	Berle douce
Water-plantain	Alisma sp.	Alisma
Waterweed	Elodea sp.	Élodée
White adder's tongue	Malaxis monophylla (Malaxis brachypoda)	Malaxis à pédicelles courts
White ash	Fraxinus americana	Frêne blanc
White baneberry	Actaea pachypoda	Actée à gros pédicelles
White birch (paper birch)	Betula papyrifera	Bouleau à papier (bouleau blanc)
White elm (American elm)	Ulmus Americana	Orme d'Amérique (orme blanc)
White fringed orchid	Platanthera blephariglottis	Habénaire à gorge frangée
White hellebore	Veratrum viride	Verâtre vert (tabac du diable)
White pine	Pinus strobus	Pin blanc
White snakeroot	Ageratina altissima (Eupatorium rugosum)	Eupatoire rugueuse
White spruce	Picea glauca	Épinette blanche
White water crowfoot	Ranunculus aquatilis var. calvescens	Renoncule à long bec
Whorled loosestrife	Lysimachia quadrifolia	Lysimaque à quatre feuilles
Wild leek	Allium tricoccum	Ail trilobé (ail des bois)
Wild lily-of-the-valley	Maianthemum canadense	Muguet
Wild rice	Zizania sp.	Riz sauvage
Wild strawberry	Fragraria virginiana	Fraisier des champs

English	Latin	French
Wild-raisin	Viburnum nudum (Viburnum cassinoides)	Alisier (bleuet sains)
Willow	Salix sp.	Saule
Wintergreen (teaberry)	Gaultheria procumbens	Thé des bois (gaulthérie couchée)
Witch-hazel	Hamamelis virginiana	Hamamélis de Virginie (Café du diable)
Wood fern	Dryopteris sp.	Dryoptère
Yarrow	Achillea millefolium	Herbe à dindes
Yellow birch	Betula alleghaniensis	Bouleau jaune (merisier)
Yellow crottle (a lichen)	Pseudocyphellaria crocata	Pseudocyphellaria crocata
Yellow lady's-slipper	Cypripedium parviflorum	Cypripède jaune
Yellow oxytropis (stemless locoweed)	Oxytropis campestris var. johannensis	Oxytropis jaune tardif
Yellow screw-stem	Bartonia virginica	Bartonie de Virginie

MOLLUSCS

Northern quahog	Mercenaria mercenaria	Quahaug
Yellow lampmussel	Lampsilis cariosa	Lampsile cariosa

MARINE INVERTEBRATES

Fundy mud shrimp	Corophium volutator	Crevette fouisseuse
Sea urchins	Phylum Echinodermata, Class Echinoidea	Oursin
BUTTERFLIES AND MOTHS	BUTTERFLIES AND MOTHS	
Bronze copper	Lycaena hyllus	Bronzé
Clayton's copper (Dorcas copper)	Lycaena dorcas claytoni	Cuivré de la potentille
Crowberry blue (northern blue)	Lycaeides idas (incl. subsp. empetri)	Bleu nordique
Early hairstreak	Erora laeta	Lutin mystérieux
Eastern pine elfin	Callophrys niphon (Incisalia niphon)	Lutin des pins
Elfin butterflies	Callophrys spp.	Lutins
Great spangled fritillary	Speyeria cybele	Argynne cybèle
Greenish blue	Plebejus saepiolus	Bleu verdâtre
Hoary comma	Polygonia gracilis	Polygone gracile
Hoary elfin	Callophrys polios (Incisalia polios)	Lutin grisâtre
Jutta arctic	Oeneis jutta ascerta	Nordique des tourbières
Little wood satyr	Megisto cymela	Petit satyre des bois
Maritime ringlet	Coenonympha nipisiquit	Satyre fauve des Maritimes
Purple lesser fritillary	Boloria chariclea grandis (Boloria titania)	Boloria pourpré
Salt-marsh (Dorcas) copper	Lycaena dorcas dospassosi	Cuivré des marais salés
Short-tailed swallowtail	Papilio brevicauda bretonensis	Papillon queue-courte
Silvery checkerspot	Chlosyne nycteis	Damier argenté
Spruce budworm	Choristoneura fumiferana fumiferana	Tordeuse de l'épinette
Western pine elfin	Callophrys eryphon (Incisalia eryphon)	Lutin chevronné (lutin du pin gris)
Western tailed-blue	Everes amyntula	Bleu porte-queue de l'Ouest
Yellowbanded day sphinx (moth)	Proserpinus flavofasciata	Sphinx de l'épilobe (papillon de nuit)

FISH

American eel	Anguilla rostrata	Anguille d'Amérique
Arctic char	Salvelinus alpinus	Omble chevalier (truite mouchetée)
Atlantic salmon	Salmo salar	Ouananiche (saumon de l'Atlantique)
Blueback herring	Alosa aestivalis	Alose d'été
Brook trout (sea trout)	Salvelinus fontinalis	Omble de fontaine (truite de mer)
Gaspereau (alewife)	Alosa pseudoharengus	Gaspareau (faux hareng)
Lake trout	Salvelinus namaycush	Touladi (truite grise)
Pygmy smelt	Osmerus spectrum	Éperlan nain
Shortnose sturgeon	Acipenser brevirostrum	Esturgeon à museau court
Smallmouth bass	Micropterus dolomieui	Achigan à petite bouche
Striped bass	Morone saxatilis	Bar rayé
White sucker	Catostomus commersoni	Meunier noir
Yellow perch	Perca flavescens	Perchaude

REPTILES AND AMPHIBIANS

Bullfrog	Rana catesbeiana	Ouaouaron (grenouille taureau)
Eastern gray treefrog	Hyla versicolor	Rainette grise (rainette versicolore)
Four-toed salamander	Hemidactylium scutatum	Salamandre à quatre doigts
Mink frog	Rana septentrionalis	Grenouille du Nord
Wood turtle	Clemmys insculpta	Tortue des bois

BIRDS

American bittern	Botaurus lentiginosus	Butor d'Amérique (butor américain)
American black duck (black duck)	Anas rubripes	Canard noir
Arctic tern	Sterna paradisaea	Sterne arctique
Atlantic puffin	Fratercula arctica	Macareux moine
Bald eagle	Haliaeetus leucocephalus	Pygargue à tête blanche
Barred owl	Strix varia	Chouette rayée
Belted kingfisher	Ceryle alcyon	Martin-pêcheur d'Amérique
Bicknell's thrush	Catharus bicknelli	Grive de Bicknell
Black tern	Chlidonias niger	Guifette noire (sterne noire)
Black-crowned night-heron	Nycticorax nycticorax	Bihoreau gris (bihoreau à couronne noir)

English	Latin	French
Blue-winged teal	Anas discors	Sarcelle à ailes bleues
Bufflehead	Bucephala albeola	Petit garrot
Common goldeneye	Bucephala clangula	Garrot à oeil d'or (garrot commun)
Common loon	Gavia immer	Plongeon huard
Common merganser	Mergus merganser	Grand harle
Common tern	Sterna hirundo	Sterne pierregarin
Cormorant	Phalacrocorax spp.	Cormoran
Eider duck	Somateria sp.	Eider
European starling	Sturnus vulgaris	Étourneau sansonnet
Fieldfare	Turdus pilaris	Brive litorne
Fork-tailed flycatcher	Tyrannus savanna	Tyran des savanes
Fox sparrow	Passerella iliaca	Bruant fauve
Goldeneye	Bucephala sp.	Garrot
Gray-cheeked thrush	Catharus minimus	Grive à joues grises
Great blue heron	Ardea herodias	Grand héron
Greater scaup	Aythya marila	Fuligule milouinan (grand morillon)
Green-backed heron (green heron)	Butorides virescens	Héron vert
Gull	Larus sp.	Mouette ou Goéland
Harlequin duck	Histrionicus histrionicus	Arlequin plongeur (canard arlequin)
House sparrow	Passer domesticus	Moineau domestique (moineau cisalpin)
King eider	Somateria spectabilis	Eider à tête grise
Marsh wren	Cistothorus palustris	Troglodyte des marais
Osprey	Pandion haliaetus	Balbuzard pêcheur (aigle-pêcheur)
Palm warbler	Dendroica palmarum	Paruline à couronne rousse
Pied-billed grebe	Podilymbus podiceps	Grèbe à bec bigarré
Piping plover	Charadrius melodus	Pluvier siffleur
Purple sandpiper	Calidris maritima	Bécasseau violet
Razorbill	Alca torda	Petit pingouin
Ruffed grouse	Bonasa umbellus	Gélinotte huppée
Scarlet tanager	Piranga olivacea	Tangara écarlate
Scissor-tailed flycatcher	Tyrannus forficatus (Muscivora forficata)	Tyran à longue queue
Scoter	Melanitta sp.	Macreuse
Sedge wren	Cistothorus platensis	Troglodyte à bec court
Semipalmated plover	Charadrius semipalmatus	Pluvier semipalmé
Semipalmated sandpiper	Calidris pusilla	Bécasseau semipalmé
Tern	Sterna sp.	Sterne
Virginia rail	Rallus limicola	Râle de Virginie
Warbling vireo	Vireo gilvus	Viréo mélodieux
Willet	Catoptrophorus semipalmatus	Chevalier semipalmé
Wilson's phalarope	Phalaropus tricolor	Phalarope de Wilson
Wood duck	Aix sponsa	Canard branchu
Wood thrush	Hylocichla mustelina	Grive des bois
Yellow rail	Coturnicops noveboracensis	Râle jaune

MAMMALS

American pine marten	Martes americana	Marte d'Amérique
Beaver	Castor canadensis	Castor
Big brown bat	Eptesicus fuscus	Sérotine brune (Grande chauve-souris brune)
Black bear	Ursus americanus	Ours noir
Canada lynx	Lynx canadensis	Lynx du Canada
Caribou	Rangifer tarandus	Caribou
Eastern pipistrelle	Pipistrellus subflavus	Pipistrelle de l'Est
Gaspé shrew	Sorex gaspensis	Musaraigne de Gaspé
Labrador collared lemming	Dicrostonyx hudsonius	Lemming à collerette du Labrador
Little brown bat	Myotis lucifugus	Petite chauve-souris brune (Vespertilion brun)
Long-tailed shrew (rock shrew)	Sorex dispar	Musaraigne longicaude
Maritime shrew	Sorex maritimensis	Musaraigne des Maritimes
Moose	Alces alces	Orignal
Muskrat	Ondatra zibethicus	Rat musqué
Northern long-eared bat (northern myotis)	Myotis septentrionalis	Chauve-souris nordique
Norway rat	Rattus norvegicus	Rat surmulot
Rock vole (yellow-nosed vole)	Microtus chrotorrhinus	Campagnol des rochers
Vancouver Island marmot	Marmota vancouverensis	Marmotte de l'Îsle Vancouver
White-tailed deer	Odocoileus virginianus	Cerf de Virginie

Appendix 4

Bibliography

Atlantic Geoscience Society. 2001. The Last Billion Years: a geological history of the Maritime Provinces of Canada. Atlantic Geoscience Society Special Publication No. 15. Nimbus Publishing. 212 pp.

Bailey, L.W. 1864. Notes on the geology and botany of New Brunswick. Canadian Naturalist and Quarterly Journal of Science (Second Series), Vol. 1, pp. 81-97.

Belland, M. 1992. The birth of the Bathurst Mining Camp: A development history of the Austin Brook iron mine and no. 6 base-metal deposit (Popular Geology Paper 92-1). Fredericton, NB: New Brunswick Department of Natural Resources and Energy, Mines Branch, 56 pp.

Bishop, G. and B.A. Bagnell. 1999. Mount Carleton, The Appalachian range discovery site, botanical inventory 1998. Fredericton, NB: New Brunswick Department of Natural Resources and Energy, Parks and Natural Areas Branch, 261 pp.

Bondar, Roberta L. 1994. Touching the earth by Roberta Lynn Bondar. Toronto ON: Key Porter Books.

Bostock, H.S. 1970. Physiographic regions of Canada. Geological Survey of Canada, Map 1254A.

Britton, N.L. and Addison Brown (1913). An Illustrated Flora of the Northern United States, Canada and the British Possessions. Charles Scribner's Sons, Nwe York, NY.

Chiasson, R. et al. 1995. Environmentally Sensitive Areas Database. Confidential report, New Brunswick Department of the Environment.

Clayden, Stephen. 1997. Information age dawns in New Brunswick Museum herbarium. New Brunswick Museum Courier and Annual Report, Fall 1997, pp. 28-29. Saint John, NB: New Brunswick Museum.

Clayden, Stephen R. 2000. History, physical setting, and regional variation of the flora. In The Flora of New Brunswick, Second Edition by Harold R. Hinds. Biology Department, University of New Brunswick, pages 35-73.

Clayden, Stephen. 1991. William Francis Ganong (Special Supplement). Saint John, NB: NBM News, Fall 1991.

Cody, M.L. and J.A. Smallwood (ed). 1996. Long-term studies of vertebrate communities, New York: Academic Press, 597 pp.

Cogbill, Charles V. 1996. Black Growth and Fiddlebuts: The nature of old-growth red spruce. IN Mary Byrd Davis, ed. Eastern old-growth forests: prospects for re-discovery and recovery. Pages 113-125. ISBN 1-55963-409-X. Island Press, Washington, D.C.

Colpitts, M.C. J.E. Ng, T.T.M., McInnis, B.G and Zelazny, V.F. 1995. Forest soils of New Brunswick. Fredericton, NB: New Brunswick Department of Natural Resources and Energy, Timber Management Branch, and Agriculture and Agri-Food Canada, Centre for Land and Biological Resources Research, Research Branch (Contribution No. 95-38), 51 pp.

Conant, R. and J.T. Collins. 1991. A field guide to reptiles and amphibians: Eastern and Central North America (Peterson field guide series, volume 12, 3rd edition). Houghton Mifflin Company, Boston, 450 pp.

Crighton, S. and D. Bérubé. 1995. An investigation of environmentally significant areas on New Brunswick Crown Land Licenses 3 and 4. (Unpublished report produced by The Nature Trust of New Brunswick, Inc. for Miramichi Pulp & Paper, Inc., P.O. Box 5040, Miramichi, NB E1V 3N3).

Davidson, W.H. 1947. William Davidson, 1740-1790. Historical Studies, No. 6. Saint John, NB: New Brunswick Museum, 83 pp.

Davis, Ronald B. 1966. Spruce-fir forests of the coast of Maine. Ecol. Monogr. 36: 79-94.

DeGraaf, R.M., Scott, V.E., Hamre, R.H., Ernst, L. and Anderson, S.H. 1991. Forest and rangeland birds of the United States: natural history and habitat use. Agriculture Handbook 688, United States Department of Agriculture, Forest Service, 625 pp.

Dilworth, Tim, ed. 1984. Land mammals of New Brunswick. Fredericton, New Brunswick: Tim Dilworth (c/o Department of Biology, University of New Brunswick, Bag Service 45111, Fredericton, NB E3B 6E1), 228 pp.

Dzikowski, P.A. Kirby, G., Read, G. and Richards, W.G. 1984. The climate for agriculture in Atlantic Canada. Atlantic Advisory Committee on Agrometeorology, Publication No. ACA 84-2-500, Agdex No. 070, 19 pp.

Erskine, A.J. ed. 1997. Canada goose studies in the Maritime Provinces, 1950-1992. Sackville, NB: Environment Canada, Canadian Wildlife Service, Atlantic Region.

Erskine, Anthony J. 1992. Atlas of breeding birds of the Maritime Provinces. Halifax, NS: Co-published by the Nova Scotia Museum, 270 pp.

Ferguson, Laing and L.R. Fyffe. 1985. Geological highway map of New Brunswick and Prince Edward Island (Atlantic Geoscience Society Special Publication No. 2). Saint John, NB: Keystone Press.

Fowler, J. 1885. Preliminary list of the plants of New Brunswick. Bulletin of the Natural History Society of New Brunswick, Vol. 4, pp. 8-84.

Ganong, W.F. 1904. The cardinal principles of ecology. Science, Vol. 19, pp. 493-498.

Ganong, W.F. 1899. On a division of New Brunswick into physiographic districts. Bulletin of the Natural History Society of New Brunswick, Vol. 18, pp. 233-236 [+ 2 unpaginated figures].

Ganong, W.F. 1899. Preliminary outline of a plan for a study of the precise factors determining the features of New Brunswick Vegetation. Bulletin of the Natural History Society of New Brunswick, Vol. 17, pp.127-130.

Ganong, W.F. 1903. The vegetation of the Bay of Fundy salt and diked marshes: An ecological study. Botanical Gazette, Vol. 36, pp. 161-186, 280-302, 349-367, 429-455.

Ganong, W.F. 1897. Upon raised peat bogs in the Province of New Brunswick. Transactions of the Royal Society of Canada (Second Series), Section IV, Vol. 3, pp. 131-163.

Ganong, W.F. 1903. A preliminary synopsis of the grouping of the vegetation (phytogeography) of the Province of New Brunswick. Bulletin of the Natural History Society of New Brunswick, Vol. 21, pp. 47-60.

Godin, B. and M.R. Roberts. 1994. Ecological land classification for New Brunswick: The ecoprovince, ecoregion and ecodistrict levels. [Prepared for the New Brunswick Department of Natural Resources and Energy through the University of New Brunswick, Faculty of Forestry and Environmental Management, Fredericton, NB].

Gorham, Stanley W. 1970. The Amphibians and Reptiles of New Brunswick. Saint John, NB: New Brunswick Museum, 30 pp.

Hamilton, W.D. 1987. Miramichi Papers. Fredericton, NB: The Micmac-Maliseet Institute, University of New Brunswick, 204 pp.

Hay, G.U. 1894. The flora of New Brunswick. Transactions of the Royal Society of Canada (1893), Section IV, Vol. 11, pp. 45-50.

Hinds, H.R. 1983. The rare vascular plants of New Brunswick (Syllogeus Series No. 50). Ottawa, ON: National Museum of Natural Sciences, 41 pp.

Hinds, Harold R. 2000. Flora of New Brunswick, second edition. Fredericton: Biology Department, University of New Brunswick. ISBN 1-55131-015-5, 699 pp.

Hoffman, Bernard. 1955. The historical ethnography of the Micmac of the sixteenth and seventeenth centuries. [Unpublished doctoral dissertation] Berkley, CA: University of California, [1986?]. 1 microfilm reel : ill., maps ; 35 mm. (Available at: New Brunswick Department of Municipalities, Culture and Housing, Archaeological Branch, P.O. Box 6000, Fredericton NB E3B 5H1).

Keast, A. 1996. Long-term studies of northern temperate freshwater fish communities, pp. 49-72 in M.L. Cody and J.A. Smallwood (ed.), Long-term Studies of vertebrate communities, New York: Academic Press, 597 pp.

Kimmins, J.P. 1987. Forest Ecology. New York, NY: Macmillan Publishing Company, 531 pp.

Leavitt, Robert. 1991. Maliseet & Micmac: First nations of the Maritimes (2nd pilot edition). Fredericton, NB: Micmac-Maliseet Institute, University of New Brunswick, 350 pp.

Lorimer, C.G. 1977. The presettlement forest and natural disturbance cycle of northeastern Maine. Ecology 58:139-148.

Loucks, O.L. 1962. A Forest Classification for the Maritime Provinces (Department of Forestry, Forest Research Branch, Cat. No. Fo42-4362). Ottawa: Queen's Printer [Reprinted from the Proceedings of the Nova Scotia institute of Science, Vol. 25, Part 2, 1959-60, 2nd printing: October 1968], 167 pp.

Lutz, Serge Gregory. 1997. Pre-European settlement and present forest composition in Kings county, New Brunswick, Canada. Master of Forestry thesis, University of New Burnswick, Fredericton, New Brunswick. 51 pages.

MacBeath, George B. 1954. The Story of the Restigouche. Historical Studies, No. 8. Saint John, NB: New Brunswick Museum, 25 pp.

MacKinnon, William R. 1984. Over the portage: early history of the Upper Miramichi. Fredericton, NB: New Ireland Press, 134 pp.

MacNutt, W.S. 1963. New Brunswick: A history, 1784-1867. Toronto, ON: MacMillan, 496 pp.

Martin, G.L. 1990. For love of stone, Volume I: The story of New Brunswick's building stone industry (Miscellaneous Report No. 8). Fredericton, NB: New Brunswick Department of Natural Resources and Energy, Mineral Resources Division, 176 pp.

Matthew, G.F. 1869. On the occurrence of arctic and western plants in continental Acadia. Canadian Naturalist and Quarterly Journal of Science (New Series), Vol. 4, No. 2, pp. 139-166.

McAlpine, D.F. and G. Godin. 1986. New records of snapping turtles, *Chelydra serpentina*, and painted turtles, *Chrysemys picta*, from New Brunswick. Canadian Field Naturalist, Vol. 100, pp. 63-68.

McInnis, B.G. and M. R. Roberts. 1994. The effects of full-tree and tree-length harvests on natural regeneration. Nor. J. Appl. For. 11(4):131-137.

Monro, Alexander. 1972. New Brunswick with a brief outline of Nova Scotia and Prince Edward Island (Canadiana Reprint Series No. 28). Belleville, ON: Mika Studio, 385 pp.

Nature Trust of New Brunswick, Inc. 1995. Environmentally significant areas database. [Unpublished document prepared under contract to the New Brunswick Environmental Trust Fund for the New Brunswick Department of the Environment and the New Brunswick Department of Natural Resources and Energy.]

New Brunswick Department of Natural Resources and Energy. 1992. Industrial minerals: an important segment of New Brunswick's mineral industry Miscellaneous Report 10). Fredericton, NB: Mineral Resources, 52 pp.

Parks, G. and J.M. Grey. 1992. Scotia/Fundy, marine weather guide (Environment Canada Catalogue No. En 56-90/1992E). Ottawa, ON: Environment Canada, 100 pp.

Perley, M.H. 1847. Report on the forest trees of New Brunswick. Simmonds Colonial Magazine, Vol. XI, No. 42, pp. 129-155, 314-324, 412-429, June 1847.

Peterson, R.L. 1966. The mammals of eastern Canada. Toronto: Oxford University Press, 465 pp.

Pielou, E.C. 1991. After the Ice Age: the return of life to glaciated North America. The University of Chicago Press, Chicago 60637. ISBN 0-226-66812-6. 366 pp.

Place, I.C.M. 1955. *The influence of seed-bed conditions on the regeneration of spruce and balsam fir.* Can. For. Br. Bull. 117.

Power, R.G. and B.E. Matson, 1995. Ecological Land Classification in Southeastern New Brunswick. Hampton, NB: New Brunswick Department of Natural Resources and Energy Co-published by Natural Resources Canada and the Fundy Model Forest.

Province of New Brunswick. 2002. New Brunswick Atlas, 2nd Edition. Co-published by the New Brunswick Government and Nimbus Publishing. ISBN 1-55109-224-7. 94 colour plates.

Rampton, V.N., Gauthier, R.C., Thibault, J. and Seaman, A.A. 1984. Quaternary geology of New Brunswick (Memoir 416). Ottawa, ON: Geological Survey of Canada, 77 pp.

Rayburn, Alan. 1975. Geographical names of New Brunswick (Toponymy Study 2 for Canadian Permanent Committee on Geographic Names). Ottawa, ON: Department of Energy, Mines and Resources, Surveys and Mapping Branch, 304 pp.

Roberts, Lorrie. 1993. Report on the status of salt marsh habitat in New Brunswick (unpublished report). Fredericton, NB: New Brunswick Department of Natural Resources and Energy, Wetlands and Coastal Habitat Program, Fish and Wildlife Branch, 31 pp.

Roberts, Lorrie. 1992. Draft report of the St. John River floodplain wetlands (unpublished report). Fredericton, NB: New Brunswick Department of Natural Resources and Energy, Wetlands and Coastal Habitat Program, Fish and Wildlife Branch, 50 pp.

Roberts, M.R. and Wuest, L.J. 1999. Plant communities of New Brunswick in relation to environmental variation. Journal of Vegetation Science 10:321-334.

Roland, Albert E. 1982. Geological background and physiography of Nova Scotia. Halifax, NS: The Nova Scotia Institute of Science, 311 pp.

Rowe, J. Stan. 1996. Land classification and ecosystem classification. Environmental Monitoring and Assessment. Vol. 39, pp. 11-20.

Rowe, J. Stan. 1972. Forest regions of Canada (Canadian Forest Service Publication No. 1300). Ottawa, ON: Department of Environment.

Rubec, C.D.A. (ed). 1979. Applications of ecological (biophysical) classification in Canada (Ecological Land Classification, No. 7). IN Proceedings of the second meeting of the Canada Committee on Ecological (Biophysical) Land Classification (April 1978). Ottawa, ON: Environment Canada, Lands Directorate.

Seaman, Allen. [1982]. The Glacial Period. Unpublished report in files of the New Brunswick Department of Natural Resources and Energy, Mines Branch, Fredericton, New Brunswick.

Selva, Stephen. 1996. Using lichens to assess ecological continuity in northeastern forests. IN Mary Byrd Davis, ed. Eastern old-growth forests: prospects for rediscovery and recovery. Pages 353-48. ISBN 1-55963-409-X. Island Press, Washington, D.C.

Seymour, Robert S. 1992. The red spruce-balsam fir forest of Maine: evolution of silvicultural practice in response to stand development patterns and disturbances. IN Matthew J. Kelty, Bruce C. Larson and Chadwick D. Oliver (eds.), The ecology and silviculture of mixed-species forests. pages 217-244. Kluwer Academic Publishers.

Shaw, Marilyn. 1987. Mount Carleton Wilderness: New Brunswick's unknown north. Fredericton, NB: Fiddlehead Poetry Books & Goose Lane Editions, 101 pp.

Shuter, B.J. and J.R. Post. 1990. Climate, population viability, and the zoogeography of temperate fishes. Transaction of the American Fisheries Society, Vol. 119, pp. 314-336.

Sobey, D.G. 1993. Analysis of the ground flora and other data collected during the 1991 Prince Edward Island forest inventory. P.E.I. Department of Energy and Forestry, Charlottetown, P.E.I.

Soucoup, Dan. 1997. Historical New Brunswick. Lawrencetown Beach, NS: Potterfield Press, 255 pp.

Spencer, Grace. 1987. A History of early Boiestown. Boiestown, NB: Central New Brunswick Woodsmen's Museum, 251 pp.

St. Peter, C. 1978. Geology of parts of Restigouche, Victoria and Madawaska Counties, northwest New Brunswick, NTS 21 N/8, 21 N/9, 21 O/5, 21 O/11, 21 O/14 (Report of Investigation 17). Fredericton, NB: New Brunswick Department of Natural Resources, Mineral Resources Branch, 69 pp.

Thomas, Anthony W. 1996. A preliminary atlas of the butterflies of New Brunswick (Publications in Natural Science, No. 11). Saint John, NB: New Brunswick Museum, 41 pp.

Toner, Maureen. 1998. Working paper on the application of ecological land classification to wetlands (unpublished report). Fredericton, NB: New Brunswick Department of Natural Resource and Energy, Crown Lands Branch.

Trigger, Bruce G. ed. 1978. Handbook of North American Indians, Volume 15: Northeast. Washington, DC: Smithsonian Institute, 924 pp.

USDA, NRCS. 2006. The PLANTS Database (http://plants.usda.gov, 18 September 2006). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

vanGroenewoud, H. and A.A. Ruitenbert. 1982. A productivity oriented forest site classification system for New Brunswick. Information report M-X-136. Maritimes Forest Research Centre, Fredericton, New Brunswick. Canadian Forest Service, Department of the Environment. 9 pp.

Waters, K. 1993. Second approximation of the New Brunswick natural regions map (unpublished report). Fredericton, NB: New Brunswick Department of Natural Resources and Energy, Recreation and Environment Branch, 47 pp.

Webb, T.C. 1985. Preliminary inventory of New Brunswick manganese occurrences (unpublished report). Fredericton, NB: New Brunswick Department of Natural Resources and Energy, Mines Branch, 98 pp.

Williams, G.L., Fyffe, L.R., Wardle, R.J. Colman-Sadd, S.P. and Boehner, R.C. eds. 1985. Lexicon of Canadian stratigraphy, Volume VI: Atlantic Region (multi-volume series published through the Canadian Society of Petroleum Geologists, Calgary, AB). Yarmouth, NS: Sentinal Printing Limited, 572 pp.

Wright, E.C. 1966. The St. John River and its tributaries (New Brunswick Museum General History Series No. 14). Wolfville, NS [based on the author's The Saint John River published in 1949], 218 pp.

Young, M.C. 1986. History of plant collections. pp. v-ix in H.R. Hinds, 1986, Flora of New Brunswick. Fredericton, NB: Primrose Press, 460 pp.

Zelazny, Vincent and Hilary Veen. 1997. The Acadian Forest, Past and Present. In Proceedings of the Technical Papers Presented at the Ecological Landscape Management Workshop, Fredericton, New Brunswick, October 5-7, 1997 (Organzed by the Canadian Woodlands Forum, Canadian Pulp and Paper Association, 1155 Metcalfe Street, Suite 1900, Montreal, PQ H3B 4T6), pp. 9-13.

Zelazny, Vincent F., Tom T.M. Ng, Michael G. Hayter, Colin L. Bowling, David A. Bewick. 1989. Field Guide to forest site classification in New Brunswick. Set of six field guides for the site regions of New Brunswick. Department of Natural Resources and Energy, Province of New Brunswick.

Zoost, J.R. 1997. The ecology and Canada goose utilization of the John Lusby salt-marsh, Chignecto National Wildlife Area, Nova Scotia. In A.J. Erskine, Ed., 1997, Canada Goose Studies in the Maritime Provinces, 1950-1992. Sackville, NB: Environment Canada, Canadian Wildlife Service, Atlantic Region.